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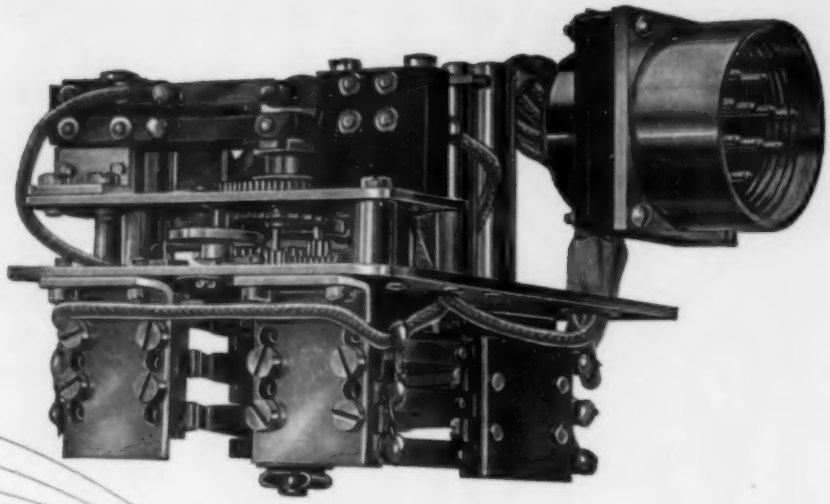

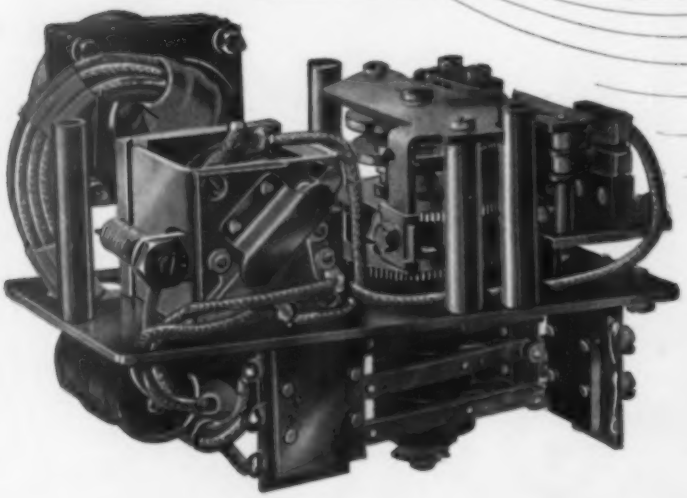

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A

COMPANY REPORT

THE BRISTOL AEROPLANE COMPANY
LIMITED

THE 44th ANNUAL GENERAL MEETING of The Bristol Aeroplane Company Limited will be held on May 20th at Filton House, Filton, Bristol.

The following is the statement by the Chairman, Sir William G. Verdon Smith, C.B.E. which has been circulated with the report and accounts for the year ended December 31st, 1953.

FINANCIAL MATTERS

The Directors' Report comments on special items in the Accounts and it is only necessary in this statement to refer briefly to one or two important features. References are to the Consolidated statements which reflect the combined results of the parent Company's Divisions and the subsidiaries.

The general picture presented by the Accounts is encouraging and your Board is again able to report that group turnover reached a new high level, both as regards sales of military equipment for H.M. Forces and other products for the home and export markets.

The Consolidated Profit and Loss Account shows that the trading profit for the year before charging depreciation has increased by £239,480 from £2,316,427 to £2,555,907. Against this we have a substantial rise in the depreciation charge from £860,796 to £1,132,443 reflecting the continued high level of our investment in buildings and plant both here and abroad, leaving our trading profits after depreciation at £1,423,464 compared with £1,455,631 in 1952.

There is now a full year's charge for interest amounting to £21,661 on the $1,200,000 of 5% mortgage bonds which, as we reported last year, were raised in Canada in 1952 in connection with the construction of our new plant in Montreal. The charge for other interest at £18,040 compares with a credit of £44,036 in the previous year, this change being largely due to the increased level of advances from our Bankers.

The total charge for taxation at £795,115 is equivalent to 58% of our profits compared with 62% in 1952.

The net profit for the year, to which all our subsidiaries have contributed, amounts to £582,661 compared with £563,829 in the previous year. This increase in net profits may be considered small in relation to a record turnover but Stockholders will realise that at a time when the Company's business is expanding there are many initial outlays to be borne out of profits in connection with the new and large projects upon which we are engaged.

The Consolidated Balance Sheet clearly illustrates the continuing expansion of our activities. Fixed Assets have risen from £5·2m. to £6·6m. following a further rise in our capital expenditure from just over £2m. in 1952 to nearly £2·5m. in 1953. Our commitments on capital expenditure at 31st December 1953 amounted to £1,322,822 and the annual outlay must continue on a substantial scale if we are to maintain our competitive position; it is therefore a matter of vital concern to Stockholders that Government policy in relation to taxation and the procurement of military equipment should permit us to retain sufficient funds to cover at least a major portion of this capital expenditure from our internal resources. We therefore welcome the new Investment Allowances introduced by the Chancellor of the Exchequer in his recent Budget.

Stocks have again increased by £1·2m. to £10.6m. though the rate of increase has been rather less than in the previous year. Debtors have increased from £4·9m. to £5·4m. reflecting increased turnover during the year. Advances from our Bankers have risen from £·68m. to £2·3m. in line with our expectations as reported to you last year. Your Board continue to keep the relationship of permanent capital and temporary borrowing under close review.

From the net profit of £582,661 the Board have made a transfer of £250,000 to general reserve which makes the total at the credit of that account £3m. and, after bringing in the balance of £455,035 from the previous year, there is a sum of £787,696 available.

The Board are recommending a Final Dividend of 6½% on the Ordinary stock making with the Interim Dividend of 3½% already paid, a total of 10% for the year and leaving £498,946 to be carried forward. The gross dividend distribution for 1953 on the Ordinary and Preference Capital, as increased in December 1952 by a bonus issue to Ordinary Stockholders, is therefore £525,000—an increase of £35,475 over the gross distribution of £489,525 in 1952. This sum of £35,475 is equivalent to an addition of slightly more than 1% on the old Ordinary Capital of £3·3m.

GENERAL REVIEW

The year 1953 was for the Company primarily one of further progress in the development of our principal new projects. At the same time our manufacturing resources were well occupied with a steady programme of aircraft and engines, and our engine overhaul shops at home and overseas were busier than ever before in peace time. We shared with the aircraft industry generally the high level of activity stimulated by the Defence Programme and we also succeeded in increasing our overseas sales in approximately the same proportion as the total export sales of the whole industry, an increase over last year of 45%. During the year we continued to add to our technical and production resources, we strengthened our overseas representation, and we brought into active operation new plants in Sunderland, Montreal and Sydney. At the same time as our current sales were increasing the prospects for further orders looked bright.

AIRCRAFT, HELICOPTERS, AND MISSILES

In our Aircraft Division, current deliveries for the year were chiefly of Bristol Freighters and of Bristol Sycamore helicopters, together with armament equipment for all three Services and a growing programme of test vehicles for the Guided Weapon Ranges in this country and in Australia.

With regard to helicopters, after a long period of disappointment a really encouraging degree of interest is now being taken in our projects by the Services as well as by civil operators, and the prospect of orders for the Sycamore and for the Type 173 has justified a substantial increase in productive capacity. This is being achieved by making our Weston-super-Mare factory a part of the Aircraft Division, establishing helicopter production there, together with our aircraft and allied work, and transferring the aluminium building activity, hitherto carried on at Weston, to other nearby premises which we shall occupy as tenants of the Ministry of Supply. The production of helicopters to British designs is now assured; during the next few years valuable experience will thus be gained, and we can now look forward to a time, in our judgment still further away than popular opinion recognises, when the civil operation of helicopters has become less of a novelty and more of a normal means of economic transport.

During the year excellent progress was made with the development and early production stages of the Britannia airliner programme. By the end of the year the prototype had flown over 220 hours and the second aircraft had just started handling trials; no major problems had been encountered, and the prospects of making the first deliveries to B.O.A.C. this year as promised looked good. It was a serious disappointment therefore to lose the second aircraft in the River Severn after an emergency landing on 4th February last. But aircraft and aero engine development is punctuated by such experiences; it is of course the very aim and purpose of development flying to learn in good time, and thus to secure the highest possible standards of flight safety for all

who will be using our aircraft on passenger services. The cause of the trouble has since been satisfactorily analysed; the remedies to be adopted have been determined; and every effort is being made to recover the time lost.

Our confidence in Britannia as an outstandingly fine aircraft is extensively shared and promising negotiations are in progress with many of the leading airlines. In order to match their estimated requirements with sufficient numbers at the right time we have made arrangements with Short Brothers & Harland Ltd. of Belfast for them to prepare capacity at their Belfast Works so as to supplement the programme already arranged at Filton.

You will appreciate that the combined programmes of both factories not only make a big demand upon our resources but represent—together with similar plans on the part of our competitors in this country—a direct attack upon the civil aviation markets of the world, the outcome of which is of great significance both to the export effort and to the technical reputation of the British aircraft industry. Neither the real risks nor the possible rewards of such a policy should be underestimated.

From the foregoing paragraphs it will be apparent that our Aircraft Division, which has been greatly strengthened and expanded during the past few years, has a big manufacturing programme ahead of it. In addition, other projects still in the early stages, as well as our guided weapons programmes, give promise of interesting and important tasks ahead.

AERO ENGINES

In our Engine Division the enthusiasm and determination of the engineering team have been handsomely rewarded by the progress which has been made with the Bristol Olympus "two-spool" turbo-jet, which is maintaining its lead as the most powerful turbo-jet engine yet flying. After securing the world's altitude record in an English Electric Canberra last summer, the Olympus was publicly displayed at the S.B.A.C. Flying Display as the accepted power plant for the Avro Vulcan Delta Bomber. Further applications of this outstandingly fine engine will be made known in due course. During last year we went ahead well with preparations for Olympus production. Deliveries from the production line start shortly, overlapping the completion of contracts for the Rolls-Royce Avon engines which have occupied much of our capacity for the past two years. In this connection it is perhaps fitting to refer to the friendly collaboration which has existed between the engine constructors who have worked so closely together both in the Avon Group and more generally. It would be hard to find another branch of industry in which the keenest rivalry in the designing and selling stages is accompanied by such a high degree of mutual help in the execution of engineering and manufacturing programmes. This unusually well developed relationship between competitors is both valuable to the Defence effort of the country and significant of the way in which the technicians in an industry can, if they are given the encouragement, blend competition and co-operation to great effect.

Last year output from our Engine Division included further deliveries of Hercules and Centaurus engines, some thousands of which continue in use throughout the world. The civil version of the Centaurus has been performing with conspicuous success in the Elizabethan fleet operated by British European Airways, and Hercules have continued to play their part with many different operators. It is likely that, on a modest scale, there will be a continuing demand for our piston engines and, of course, for their spares and overhaul for some years to come.

The Proteus turbo-prop—an engine to which, as we mentioned to Stockholders last year, we are looking for important new successes in the transport field—is, like the Olympus, just coming into production after a long and thorough programme of development and testing.

Among the new engine projects to which public reference has already been made we have in the design stage a lightweight axial turbo-jet known as the Bristol Orpheus, which we believe will have an important place as the power unit of several new aircraft—light fighters, trainers and others: it has attracted much interest both at home and overseas.

Other new projects being tackled during the year, including an extensive programme of ramjet development, hold out the prospect of a high level of production in the future.

MOTOR CARS

Bristol cars have had another successful year. The demand for the Type 403 saloon has been well sustained and our latest model, the Type 404 2-seater coupé has been well received at Motor Shows both at home and abroad. A variant of the 404 with a special Italian sports body was recently announced by the Arnolt Corporation who are marketing this model in the United States. We are continuing our policy of a steady development programme to maintain the high standard of technical excellence already achieved by this comparatively new Division of the Company. During the past year our 2-litre engines fitted to Frazer-Nash, Cooper and Kieft cars have had many notable racing successes throughout the world and in our own Bristol Type 450 achieved six international Class E records.

ALUMINIUM BUILDINGS

The comparatively high price of aluminium continues to restrict the development of this business but during the year we completed a wide variety of contracts, chiefly primary schools for local authorities, and in spite of keen competition, we continued to secure valuable orders both in the United Kingdom and overseas. The Australian market, in which our sales of aluminium buildings for schools, hospitals and other Government purposes have amounted to close on £4m. during the past three years, has now very greatly reduced, partly on account of increased availability of local building resources and partly by reason of the high import duties now charged on our products. Vigorous efforts are being made to open up other markets at home and abroad and our designs are being modified to meet changing requirements, including the development of multi-storey schools for the United Kingdom building programme, and simpler and cheaper structures for certain overseas markets.

ROTOL LTD AND BRITISH MESSIER LTD

These two associated companies traded profitably and effectively, and their resources were fully employed in meeting their rising programmes. Their scale of operations is now extensive and one or other of their products is used on practically every type of aircraft in production in this country. Their Boards have steadfastly pursued a conservative policy as a result of which the value of the net assets considerably exceeds the nominal value of the share capital and advances.

BRISTOL AEROPLANE COMPANY OF CANADA LTD

Our Canadian Company and its two operating subsidiaries had a successful year's trading and our interests in Canada continue to expand. In Montreal, Bristol Aero Engines Ltd.'s new plant, to the construction of which I referred last year, came into operation in the second half of the year and has attracted much favourable comment. Bristol Freighters, already in use with the R.C.A.F. and other Canadian operators, have also gone into service with Trans-Canada Airlines as part of an interesting campaign for the development of specialised air freight services between principal cities of Eastern Canada. More recently an agreement has been concluded with the Canadian Government under which a military version of the Bristol Britannia is to be constructed by Canadair Ltd. in collaboration with ourselves for maritime reconnaissance and other purposes. These are the first fruits of the efforts which we have made over the past five years to develop our Canadian business. It is our confident belief that further benefits will accrue in due course.

BRISTOL AEROPLANE COMPANY (AUSTRALIA) PTY LTD

Our activities in Australia are as yet on a small scale but during the year we took over from our friends the Overseas Corporation of Australia their share of the capital of Airflite Ltd. which we have now renamed Bristol Aviation Services Ltd. The leasehold premises at Bankstown Airfield have been equipped for helicopter and aircraft overhaul work and a new factory nearby has been leased and equipped for the overhaul of aero engines. Our guided weapons department has made use of the workshop premises we now occupy at Salisbury and trials of weapons sent out from Bristol have made a promising start at Woomera.

EUROPEAN ASSOCIATES

In France our associated Company, Société d'Exploitation et de Constructions Aeronautiques, continues to be actively engaged on aircraft and engine overhauls.

In Spain, the Company has participated in the formation of a new Company, Talleres Aeronauticos de Barajas, S.A., which will carry on an aircraft overhaul business at Barajas Airport, Madrid, the primary object being to provide good maintenance in Spain for the increasing number of Bristol aircraft and engines in use in that country.

RE-EQUIPMENT AND EXPANSION

During the year considerable increases were made to our fixed assets as evidenced by the increase in balance sheet value to which reference has already been made. The major part of this large sum was spent on new machine tools for both manufacturing Divisions, on new and elaborate test plant for ramjets and turbo-jets, and on conversion to turbo-jets of a section of our engine repair factory at Whitchurch near Bristol. The process of re-equipment has no finality and despite the high level of taxation we have regarded it as having a paramount claim upon our resources.

It has continued to be exceedingly difficult to attract both skilled men and design draughtsmen to the Bristol area in sufficient numbers. We have therefore further developed our branch on the North Eastern Trading Estate at Sunderland by occupying a third factory built to meet our requirements, and we have gained considerable benefit from branch drawing offices in the London area which supplement the main offices in Bristol.

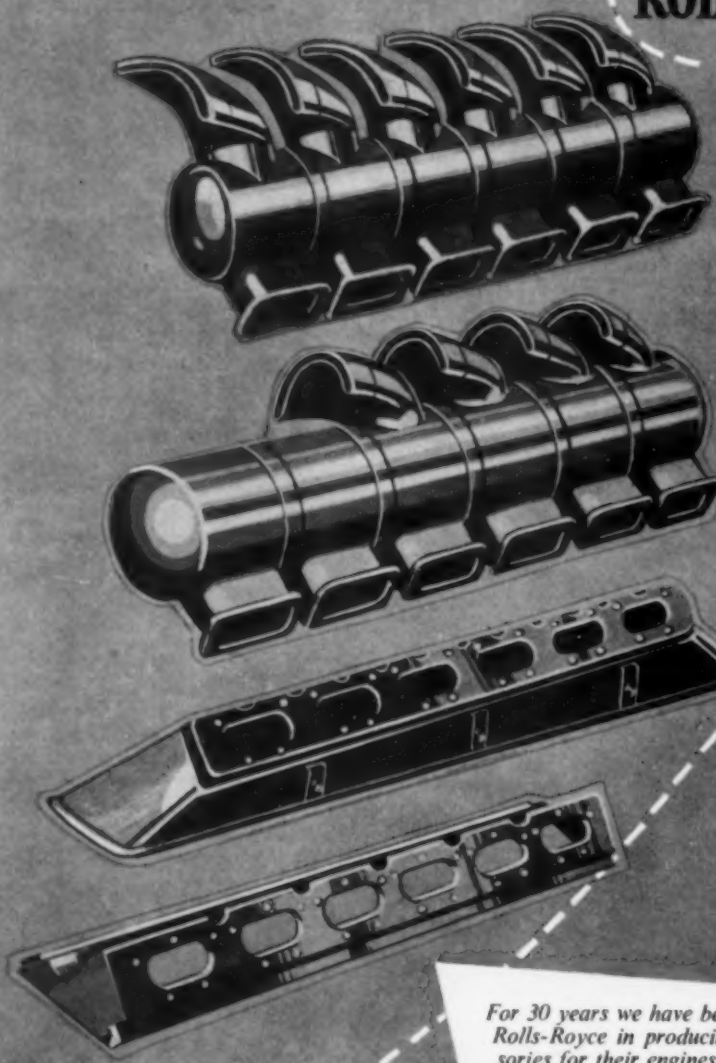
We are pressing on with the construction of our new Apprentices School in order to increase the annual intake both of trade and engineering apprentices and to raise the quality of their training. Engagement of engineering graduates has been steadily maintained and, in addition, some twenty of our Higher National Certificate engineering apprentices are currently working for their Engineering degrees in Universities. Much of our training programme is still in the experimental stages and it is good that this should be so: we have no doubt that the continuous recruitment and training of able men is of vital importance to our future—every bit as important indeed as the provision of all the expensive plant and equipment the need for which is unquestioned—and we are emphasising more and more the need for well considered schemes of selection, further training, and promotion believing that some of the best sources of talent are to be found within our own ranks.

PROSPECTS AND PROBLEMS

It is to be hoped that this review has given Stockholders a comprehensive picture both of the current state of our business and of the future outlook. On the credit side, there is every reason for having confidence in the technical merits of our products and their suitability to the market over the years ahead, and for having equal confidence in the excellence of our workmanship. We have good justification on these grounds for expecting our turnover to continue at a high level. On the other side—and this is something that applies to the whole of British industry and not just to ourselves—we cannot ignore the trend of costs, in which the basic element is the cost of wages and salaries. Despite many warnings there is still a dangerous failure to recognise that we may, by high costs, price ourselves out of the competitive markets of the world: if we do so the maintenance of a high level of employment will become impossible. There is also a dangerous and widespread failure to understand that a better standard of living depends not on bigger money incomes but on the amount of genuine and intelligent hard work contributed by each of us to our common purpose, the defence and prosperity of our country.

So far as we in this Company are concerned, we shall so far as it lies in our power continue steadily on the course which we have set ourselves—that is the course of increasing our efficiency and of providing stable employment in good and improving conditions on work which we are proud to think is of considerable service to the State. I thank once again the thousands of our staff and workpeople who by their loyalty and hard work help to make possible the achievement of these ends.

PAUL *precision metalcraft are proud of their long association with* **ROLLS ROYCE**



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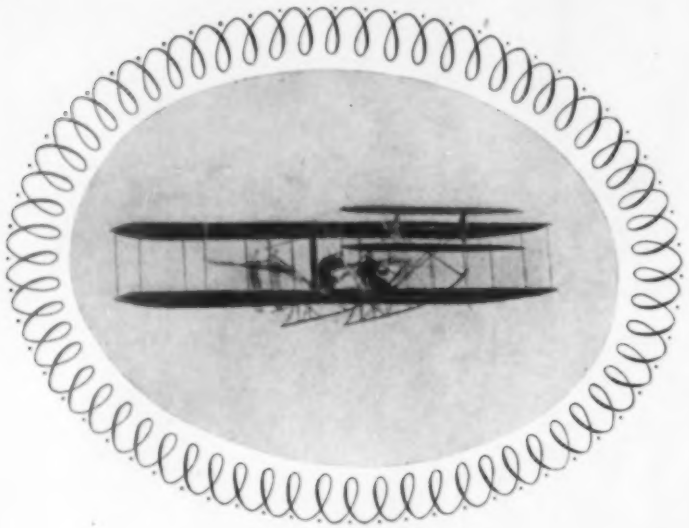

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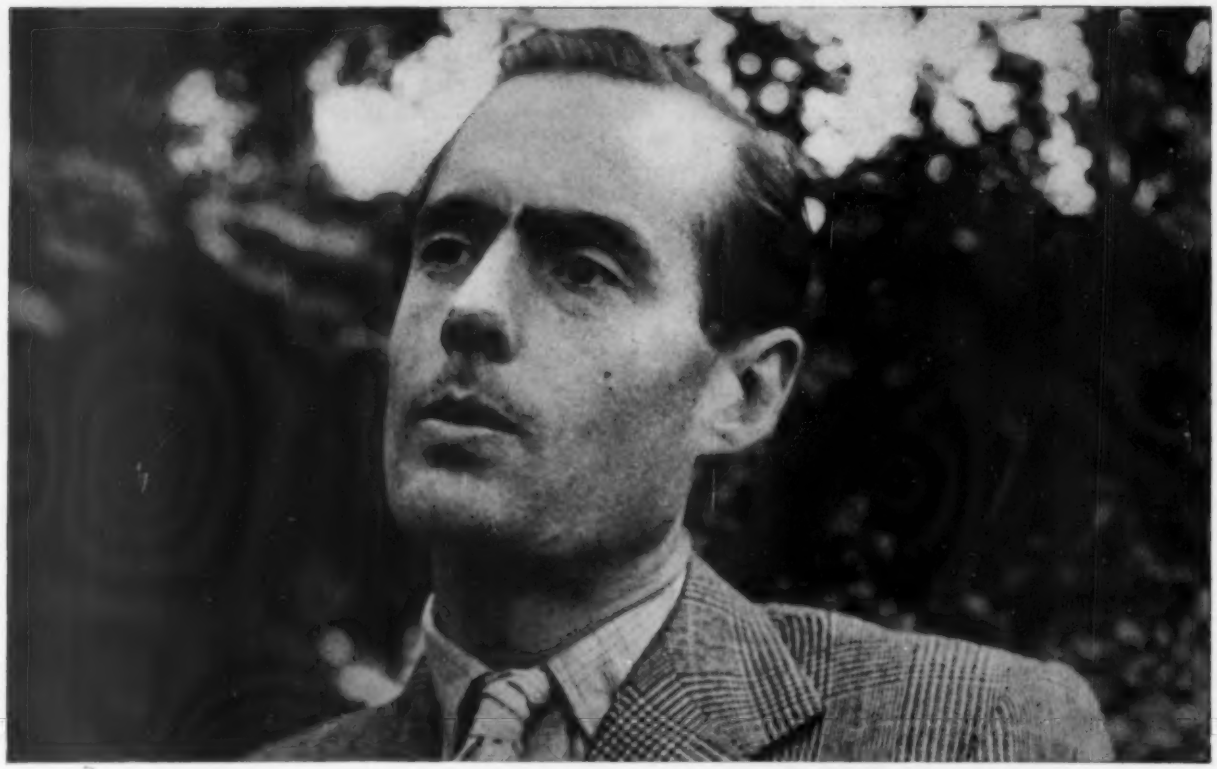

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Cheshire has told this story himself from the hospital bed in which he has spent the last 18 months fighting a winning battle against tuberculosis.

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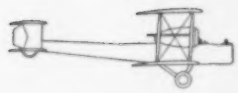

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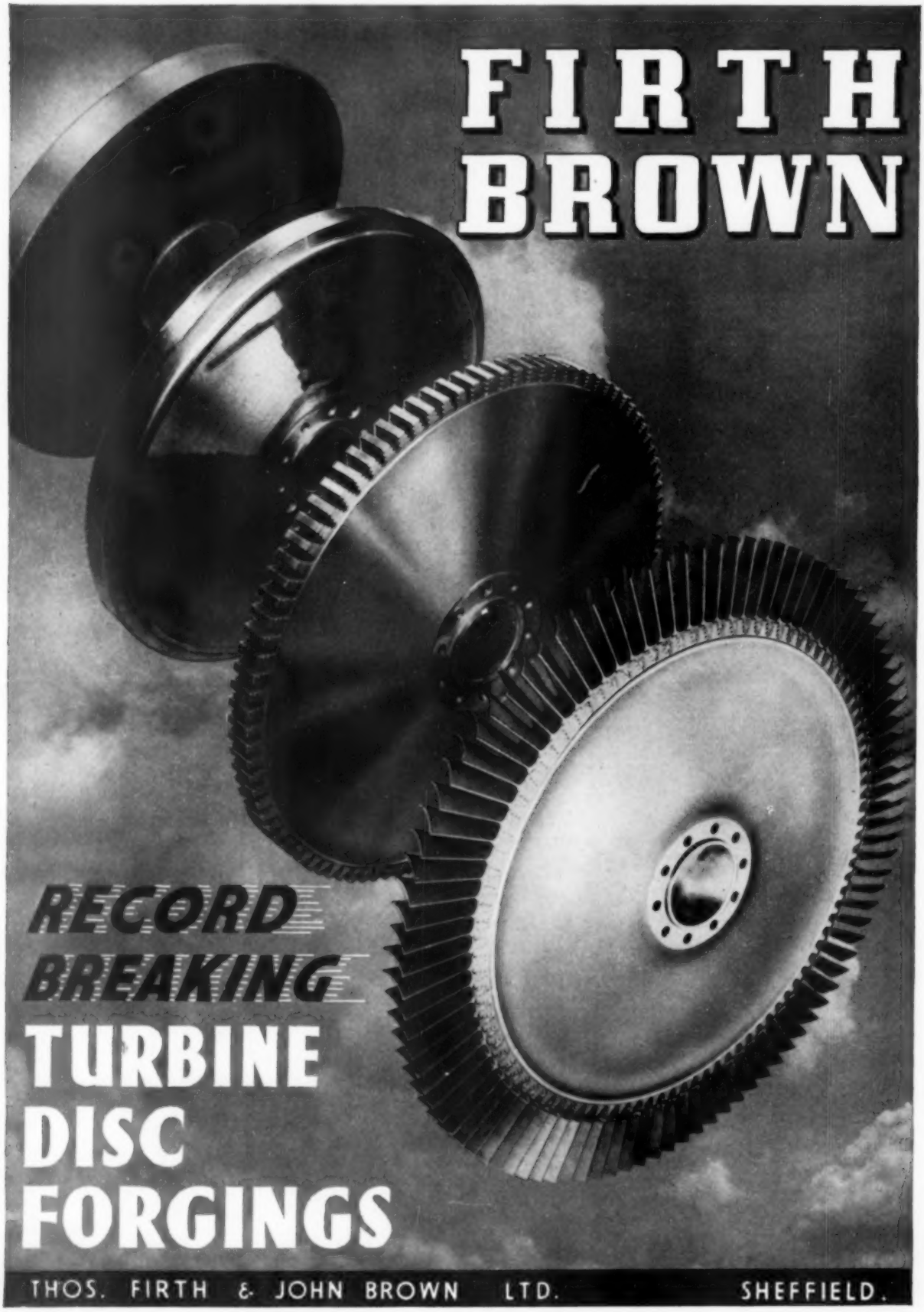
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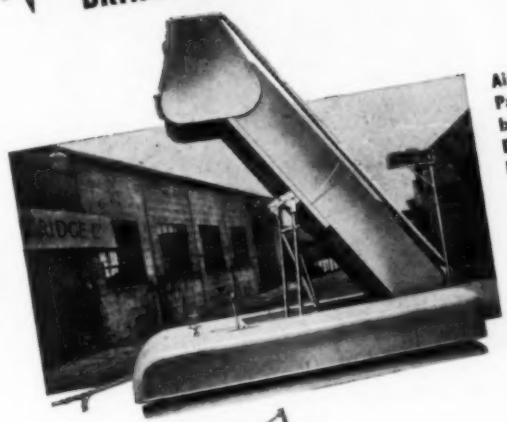
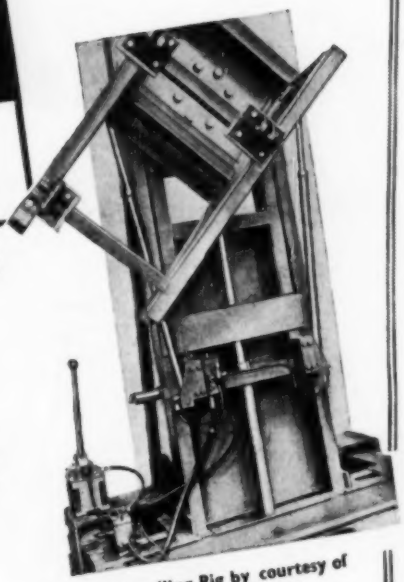
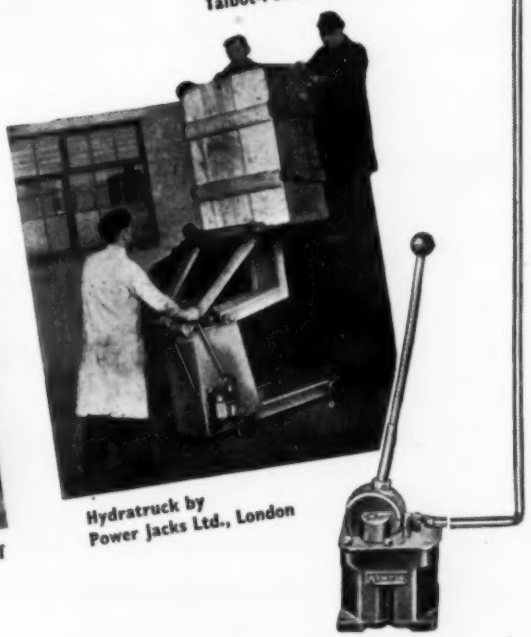


Aircraft Passenger Gangway by courtesy of B. F. Collingridge Ltd. Feltham, Middlesex



Wing Handling Rig by courtesy of Folland Aircraft Ltd. Built by Talbot-Ponsonby Ltd.

Aircraft Servicing Platform by courtesy of Charles Hill and Son Ltd., Bristol



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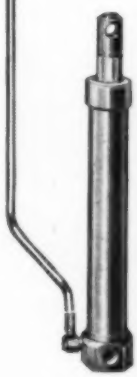

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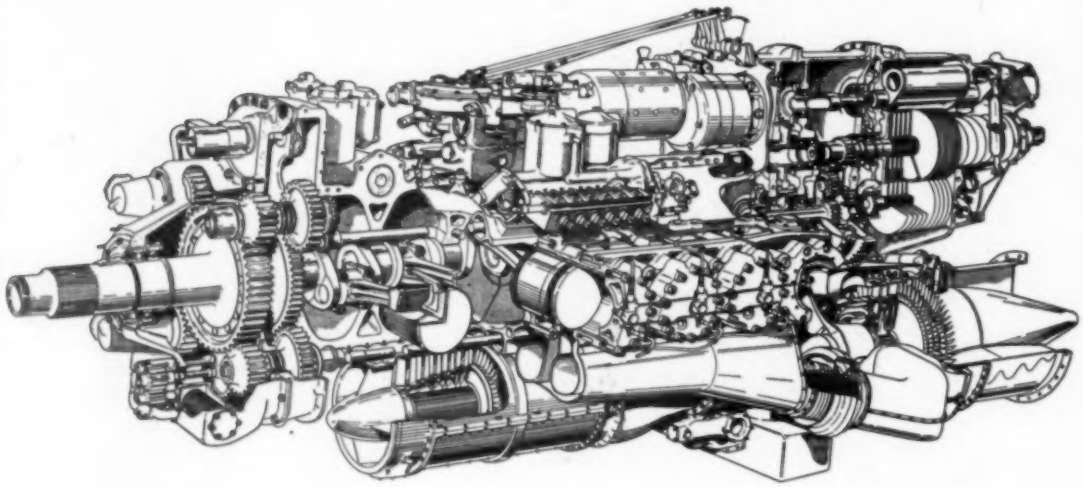

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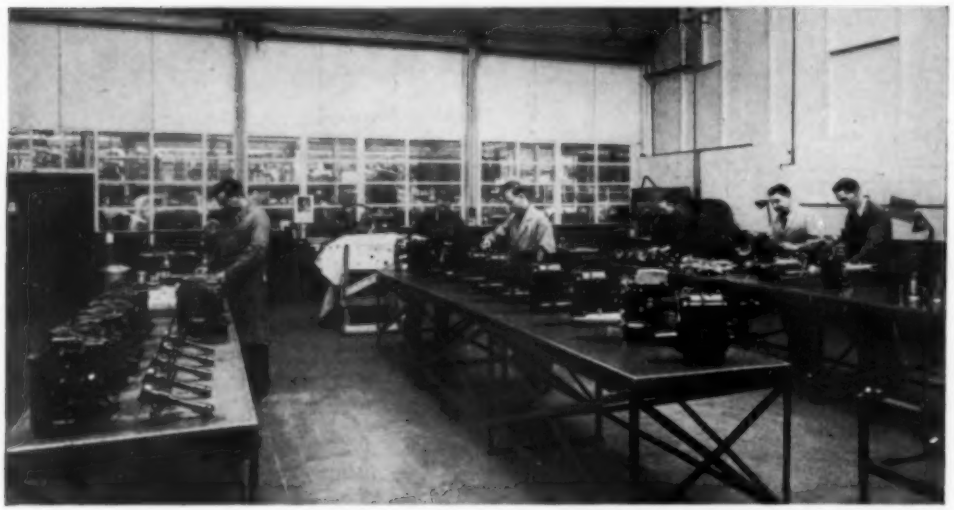

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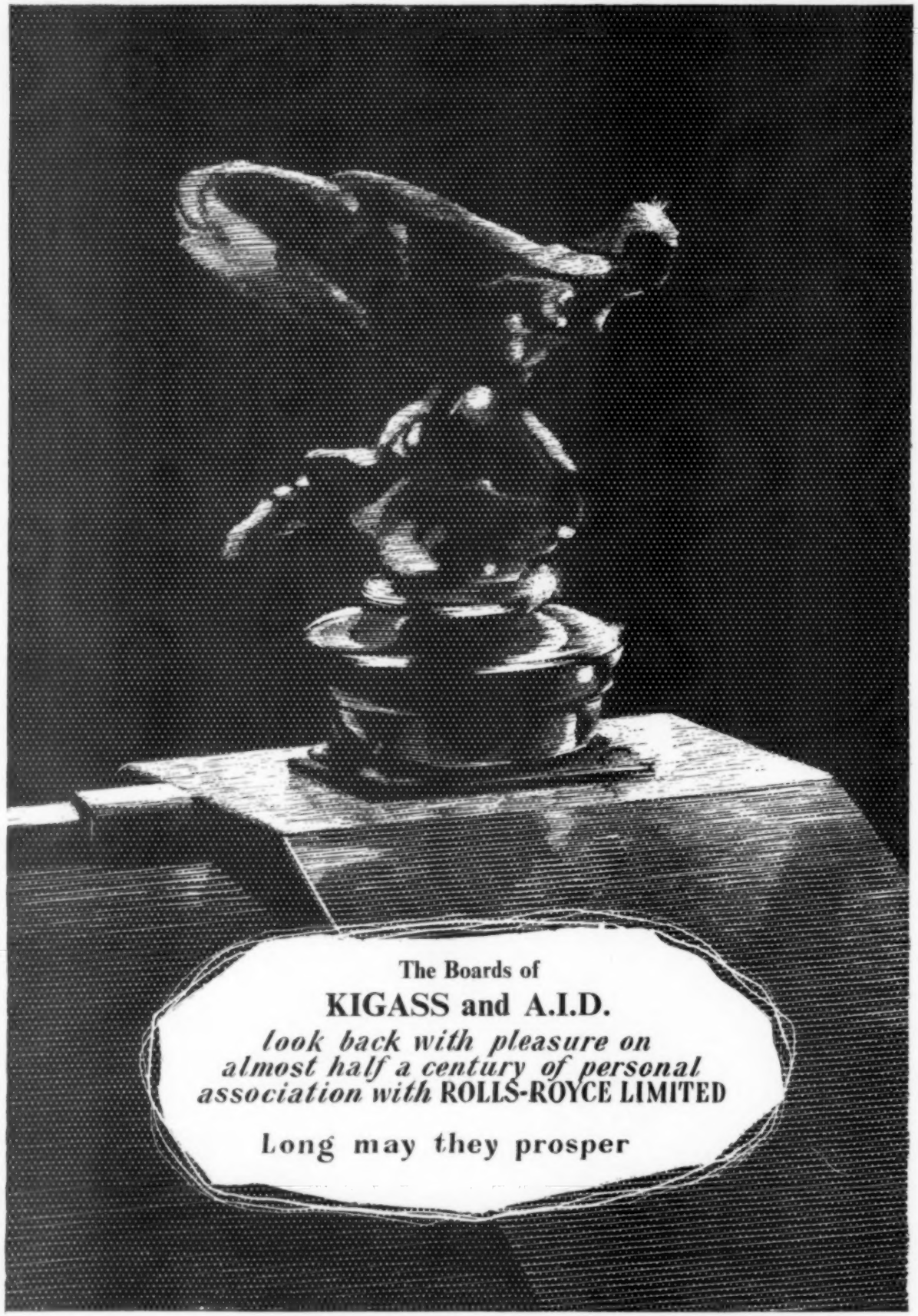
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First Aeronautical Weekly in the World

Founded 1909

No. 2363 Vol. 65. FRIDAY, 7 MAY 1954

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STAMFORD STREET,
LONDON, S.E.1.

Telegrams, Flightpres, Sedist, London.
Telephone, Waterloo 3333 (60 lines).

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The Usefulness of Gliding

WHILE hesitant to offend any observant readers who may feel the subject to be incongruous in an issue containing the story of a world-famous line of aero-engines, we think it timely to consider here some significant aspects of *unpowered* flight. We have particularly in mind the forthcoming World Gliding Championships at Camphill, which have been described by the chairman of the British Gliding Association in his report for 1953 as the greatest opportunity and greatest task ever faced by this country's gliding movement.

The fact that gliding has "grown up" and is able to contribute much of value to the science of aeronautics is still not generally realized. This fact is well illustrated, however, by the activities of OSTIV (Organisation Scientifique et Technique Internationale du Vol à Voile), the international gliding research association whose fifth congress is to take place in Buxton this summer. A study of the papers presented at the last congress in 1952 gives some idea of the scope and value of the organization's work. Those devoted to meteorology—a real knowledge of which is the essential basis for any soaring flight—merited publication as a monograph by the American Meteorological Society; less obvious yet equally important applications of gliding research were concerned with aerodynamics (in particular, work on boundary layers), aircraft design (including new methods of construction), instrument design, and aero-medical aspects of flight.

Those who fly in sailplanes—and those who design and develop them—do so for three reasons. There is the quest for high performance; the urge to fly farther and higher than others have done. This tendency, which we have heard condemned (somewhat unjustly) by certain gliding pioneers, has reached its high-efficiency peak in the type of international gliding contest held today.

There is also the quest for scientific knowledge, sometimes only secondary, but almost always present, which has led to the formation of OSTIV and to its useful programme of work.

. . . and its Enjoyment

Behind these two quests lies a third—and the most significant. It is the simple, entirely personal urge to fly: to fly for the beauty of it; for the exhilaration of it; for the fun of it. This sailplane flying is pure flying, and has little in common with the experience of sitting in a row of seats inside an airliner, or with sitting alone and more or less in control of a large, heavy piece of machinery with swept wings and much complication. True, an airliner takes one from A to B very quickly and comfortably, and a jet fighter is an unfortunate necessity in this curious world. It all depends on what one wants.

Present developments in British gliding are on the whole encouraging. The major clubs are all experiencing a steady increase in membership—though there remains scope and a real need for the formation of more clubs. New designs include both the high-performance two-seater sponsored by the B.G.A. and an excellent yet inexpensive sailplane which will fill an undoubted need of both clubs and private owners. The export value of British sailplanes, for several years now at a high level, is well appreciated. The continued Air Ministry support for A.T.C. gliding is naturally welcome, even if the motives behind it lean more towards an inducement for R.A.F. recruiting than towards a belief in the value of soaring flight as such. And, of course, there is the great opportunity of the world championships, to be organized with the enthusiasm of the British gliding community—and without Government support.

At the present time, the British Gliding Association has received donations of some £4,000, and a promise from the Kemsley Flying Trust, towards its goal of £10,000 to cover the expenses of the world championships. We feel confident that this target will be reached. We also like to believe that, in the midst of all the extremely efficient competition flying that will take place from Camphill, with high performance as its primary aim, some of the competitors will not be too weighed down by an awareness of the importance of the occasion, or by feelings of national prestige, to enjoy their soaring just for the fun of it.

FROM ALL QUARTERS

CLOVER SEED and fertilizer, to the weight of six tons, were lately sown over forty acres in twenty-four seconds at Masterton, near Wellington, New Zealand. The aircraft engaged—a Bristol Freighter of the R.N.Z.A.F.—was on loan to Industrial Flying, Ltd., for a series of trials. The set of three two-ton hoppers is shown being transferred from a lorry to the hold of the Freighter.

Naval Welcome

AS the Royal Yacht *Britannia* steams past Cowes, I.o.W., on May 14th on the final stage of the return journey from Tobruk, aircraft of the Fleet Air Arm will fly past to salute Her Majesty the Queen and H.R.H. the Duke of Edinburgh. The formations will be provided by No. 813 Sqn (Wyverns), Nos. 802, 804 and 898 Sqns (Sea Hawks) and No. 890 Sqn (Sea Venoms). These aircraft will be followed by a Sea Prince carrying the Flag Officer Air (Home), Vice-Admiral Sir John Eccles. Weather permitting, *Britannia* will pass Cowes at 6.40 p.m.

Details of the Royal Air Force fly-past when *Britannia* reaches the River Thames on the following day were given last week.

Commuting Canberras

TWO Canberra B.2s made creditably fast transit flights between the United Kingdom and the Sudan and Aden last week. One, from No. 21 Sqn, captained by F/L. M. Crosby, flew to Khartoum (3,030 miles) in 6 hr 43 min airborne time—an average speed of 451 m.p.h.—landing on the way at Castel Idris, Tripoli, to refuel. At Khartoum the aircraft is carrying out hot-weather trials on certain equipment, and it is then due to fly to Singapore.

The other Canberra, captained by F/L. D. B. Cartledge, covered the 3,885 miles from Aden to Tangmere in 8 hr 19 min flying time, with refuelling stops at Fayid and Malta.

G.A.P.A.N. Meeting

AT the recent annual general meeting of the Guild of Air Pilots and Air Navigators of the British Empire, Capt. D. A. Brice, the retiring Master, announced that his successor would be Capt. J. C. Harrington, O.B.E., F.R.G.S., deputy operations director of B.O.A.C. The Court had also elected Capt. B. C. Frost, Capt. O. P. Jones and Capt. A. G. Lamplugh as its new wardens.

Concerning the three trophies normally awarded annually by the Guild, the committee had decided that the Brackley Trophy would not be awarded this year. The Johnston Trophy had been awarded to the pilots and navigators of the B.O.A.C. Comet Fleet for their great pioneering efforts in developing navigational techniques connected with fast jet aircraft flying at high altitudes, and the recipient of the Cumberbatch Trophy, awarded for outstanding contributions to the reliability and safety of air transport, was British West Indian Airways. It was hoped to make an announcement in the near future concerning the Derry and Richards Memorial Medal for the most outstanding test pilot of the year.

Simulating Homo Sapiens

IN order that their new automatic ejection seats may be fully tested, Martin-Baker, Ltd., have blown such seats from the rear cockpit of a Meteor 7 while they were occupied by a "simulated" average man. Following the specification laid down by the manual of design requirements (A.P.970), the company has made three precise human frames in steel, with the correct weights, c.g. positions and joint movements. An accelerometer is fitted inside the skull of each.

For a test, the dummy is secured in the Meteor with full equipment, and with the seat blind pulled over its face. At the appropriate moment the rear seat is fired by the pilot, and the ejection is recorded on film. To date, ejections have been made at heights as low as 120-150ft; at the latter height, there were 80ft in hand at the moment of full deployment of the main parachute. Eventually it is hoped to eject at 60ft.

Aircraft and Golf

TRIBUTES to the retiring president, Mr. Robert Blackburn, and to his successor, Brigadier-General A. C. Critchley, were paid by Mr. Brian D. Songhurst, secretary of the Aircraft Golfing Society, at the Society's tenth annual dinner in London last Friday. In his response, Brig-Gen. Critchley remarked that there was not enough forward thinking in civil aviation. We had had eight Ministers in as many years, he said, and he wanted to know how a Minister could look ahead if he was being retired "tomorrow morning." He made a heartfelt plea for large flying-boats, and foresaw 1,000-ton jet-propelled machines plying between the Solent and New York.

Proposing "The Society," Mr. John Gordon, editor of the *Sunday Express*, spoke of flying in the Soviet Union, of the rough-and-ready practices current there, and of his consternation on seeing a "woman driver" in the cockpit. The Society's captain, Mr. H. W. Littleales, responded.

A warm tribute to the Press—especially to the technical Press—was paid by Mr. Eric Turner (managing director, Blackburn and General Aircraft). In welcoming Sir Roy Dobson as the guest of honour, he referred to "something exciting" to emerge from Avros in three months' time. In a sparkling Dobsonian response, Sir Roy described Brig-Gen. Critchley's views on flying-boats as "completely out of date." Sir Roy believed that one of the duties of an aircraft golfing society was to get personnel of the industry together, so that they could let their hair down.

Pressurization Failure

AN exceptional mishap—the failure of the pressure-cabin sealing in a Vickers Viscount—was reported during a scheduled B.E.A. flight on Wednesday, April 28th. The aircraft was at 23,000ft over Dijon when the door of the forward freight hold opened slightly and de-pressurization took place. An emergency descent to 12,000ft (during which no passengers suffered seriously) was made by Capt. J. Monroe, followed by a landing at Geneva.

A B.E.A. spokesman stated later that a broken forging in the door mechanism was responsible for the opening of the door.

BOEING BEHEMOTH: The frontal view shows the first Boeing B-52A Stratofortress with under-wing tanks fitted. Also apparent is the rationalized cockpit, with side-by-side seating, and otherwise differing considerably from the tandem disposition which characterized the original B-52, a most impressive take-off shot of which also appears.

BUILDING the HUNTER

"Unit Assembly" in Three Countries Described by Hawker Executive

Mr. E. H. Jefferson.

SOME revealing sidelights were thrown on Hunter production in a recent lecture to the Aeronautical Division of the Society of Automotive Engineers in New York. It was given, shortly after his arrival on a visit to America, by Mr. E. H. Jefferson, who is general manager of Hawker Aircraft (Blackpool), Ltd., and a director of the parent company.

The British Government, said Mr. Jefferson, ordered the Hunter for the R.A.F. "off the board." The "instruction to proceed" was placed in October 1950 and the contract followed six months later. The first production aeroplane flew in May 1953. Thus, from the date that Hawker Aircraft first knew they were going to receive an order to the time when the first production Hunter was flying, only two years and seven months elapsed.

The Hunter was a new aircraft; therefore the company had to start from zero and build up a completely new production set-up —this when production of other types had been allowed to run down, with loss of much skilled labour which sometimes seemed almost impossible to replace.

Early Production Methods and Difficulties.—An even more serious aspect was the finding of firms to make large jigs and tools in the numbers required. The Hunter required some 3,250 tool designs, and about 40,000 jigs, tools and fixtures had to be provided for. To break the bottleneck the British Government introduced the "super-priority" scheme. This only partially produced the required results, since priority had to be allocated to so many items that suppliers and sub-contractors were often unable to give any measure of preference. In addition, every effort was being made to maintain exports.

Eventually, tool-making difficulties were overcome by a combination of two methods. The first took care of initial detail and sub-assembly work and involved a compromise—the development and use of "rough tools," prepared not by the virtually unobtainable toolmakers but by skilled fitters. Although capable of manufacturing several hundred parts these tools were intended as a temporary measure. Such methods obviously could not be employed for major assembly jigs; here it was a matter of searching far and wide until someone with the capacity to accept orders could be found. Eventually a large number of jigs were obtained from such Italian firms as Macchi, Breda and Fiat.

Assembly.—To facilitate manufacture, the Hunter was broken down into main assembly units, e.g. front fuselage, centre fuselage, rear fuselage, wings. This was common practice, but with the Hunter it was carried a stage farther. Each major component was not only built as a separate structural unit but was complete in itself, containing all ancillary equipment, services, pipes and runs, as in the finished aircraft. Thus for final assembly it was necessary only to connect the structural members and plug the pipes and leads together.

One reason for this method was the difficulty inherent in building an aeroplane in a number of factories some distance apart. During the early days the resources of the entire Hawker Siddeley Group were pooled for difficult items. Hawker Aircraft itself was far from being housed all under one roof. Production plans, therefore, called for the detail parts and main assemblies to be made in several places, with Kingston-upon-Thames as headquarters. There were two other factories in the South of England and assemblies were fed to the final-assembly plant and airfield about 50 miles from Kingston. Certain specialized components were sent 250 miles from Hawker Aircraft (Blackpool), Ltd.

Off-Shore Procurement.—Work on the Hunter for the R.A.F. was proceeding at a satisfactory rate when the U.S.A. off-shore procurement order was placed with the British Government early last summer. So far as Hawker Siddeley were concerned, the new contract called for some 450 Hunters to be delivered by June 1956.

It was impossible for new factories to be erected in order to build off-shore Hunters alone; that was not, in fact, necessary. The order was being met from the existing organization by continuing production at the peak rate which had been planned to meet as quickly as possible R.A.F. requirements. Thus the off-shore order assured a longer run of peak production and promised a level of capacity not otherwise possible. As the aircraft were completed, the M.o.S. and NATO representatives would decide between themselves which would go to the R.A.F. and which to other NATO countries.

Holland and Belgium.—The many problems were intensified by the fact that off-shore orders were also placed with Holland and Belgium; thus eventually Hunters would also be built by three companies in Holland—Fokker (who are to undertake the majority of manufacture in that country), Aviolanda and de Schelde—and by two in Belgium—S.A.B.C.A. and Avions Fairey. There were the normal array of sub-contractors to each one company. The Netherlands and Belgium would between them manufacture some 100 off-shore Hunters by the summer of 1956, and thereafter would produce further Hunters for their Governments.

Since the war Holland had made Meteors from raw materials; in Belgium, however, the manufacturing side barely existed, except for Avions Fairey. But the country had an industrial tradition and her machine-tool industry was capable of undertaking any work entrusted to it. A large number of jigs and tools had been ordered through Hawker Aircraft in the United Kingdom for both countries, but Belgium had ordered these items in her own territory as well; S.A.B.C.A. had erected a new factory and were in process of receiving special plant from the U.S.A.

Broadly speaking, each of the companies engaged had certain responsibilities, each making various detail parts and sub-assemblies. Some factories would then incorporate these into main assemblies and finally the main units would be brought together—by S.A.B.C.A. in Belgium and by Fokker in Holland. In Belgium, Avions Fairey would make only detail parts and sub-assemblies and would be provided with some finished parts, and with main assemblies, by Hawker Aircraft—and, later, by Holland. Thus the pattern previously worked out of necessity in Great Britain would virtually be reproduced on the Continent. And such was the degree of standardization that components made anywhere in the three countries would be interchangeable.

Hawker teams were constantly going to both countries to advise and assist, and technicians and operatives were continually coming to England to be trained.

Much information and material had been supplied, including complete sets of master aircraft drawings and schedules, pre-production manufacturing information, jig and tool drawings, details of manufacturing processes, and master part schedules.

Hawker Aircraft were sending teams to Holland to install the major jigs. To get work started they were supplying 50 initial sets of raw materials and complete sets of master templates, tooling aids and interchangeability media. Holland and Belgium were being provided with sample components—including two complete aircraft, one for each country, and a whole set of specimen detail parts—so that engineers would see the standards to which they would be required to work. Sets of all pipe runs were being sent, as the forms of such parts were difficult to visualize accurately from drawings. The complete aircraft would help both countries to get accustomed to all that was involved in the construction of a complicated fighter, and to develop the flying, servicing and ground-handling techniques it would necessitate.

In addition, Hawker Aircraft were providing components, skeleton components and sub-assemblies.

Machine Tools.—Many special machine tools for the Hunter, both on the Continent and in Britain, had been obtained from the U.S.A. Certain machined components for the wing and fuselage attachments were made from forgings of high-tensile steel. In their manufacture a large amount of profile and contour milling was involved, and for this work American duplex milling machines and Hydro-Tels had been found invaluable. The company also used Hufford and Sheridan stretch-forming machines, Onsrud spar-millers, Farnham rolls, Verson brake-presses and, for pipe manipulation, Pines benders. The great deal of formed sheet-metal work called for at Hawker Aircraft was done on Cecostamps, employing light-alloy dies, which could be altered easily and economically in the event of modifications.

Provision for Dispersal.—In an emergency, the long lines of production jigs in the Hawker factories could quickly be dispersed to safe areas. All main jigs were erected on rafts made of a structure of rising steel joists, welded together and provided with jacking points for levelling up. This was useful even in peace, for the jigs could be moved to any part of the country where labour was available. The method would also prove invaluable in setting up production on the Continent.

In conclusion the lecturer said he would like to emphasize the keenness that was being displayed by everyone concerned with the work on the Hunter in all the three countries. There was a very real feeling that nothing should stand in our way to hold things up for one moment. Barriers had been broken down and understanding and unity was being achieved. This in itself was a very worth-while supplementary benefit arising from off-shore procurement orders.

THE AIR FORCE: These Sikorsky H-19s belong to the U.S.A.F. Troop Carrier command; they are seen bringing in infantry during exercise "Long Horn" in Texas.

HELICOPTERS IN WAR

An Appraisal of the U.S. Army's Experience of Rotating-winged Transport

FOR various reasons—principally a lack of suitable aircraft and a lack of finance—the United Kingdom has paid no more than lip-service to the possibilities of military transport offered by the helicopter. Of the small number of rotary-wing aircraft in service with the British Services, hardly any are used for transport as such; most are employed in rescue, personal liaison and similar rôles. The United States, however, has been using helicopters *en masse* for long enough to know exactly what can be done and a recent report, *Army Helicopters*, issued by the Office of the Army Chief of Transportation, puts the results of the period 1950-53 into a nutshell.

The report begins by outlining the background of Army logistic and front-line support, first with the Army Mule (four-legged variety), and then with the Jeep, the submersible Eager Beaver and the tracked Weasel and Otter, which accept any type of terrain.

In 1949, the U.S. Army had sufficient helicopter experience to issue a requirement for a number of these machines large enough to carry personnel, cargo and equipment; these were to be used in the combat zone itself, by-passing all natural obstacles. Special units were raised, capable of making the fullest use of the new form of travel; by November 1950, the first helicopter transportation company had been "activated," with an establishment of 21 aircraft. Its task was the movement of one rifle company specially trained in the new technique.

Since that date, the first unit—the 6th Transportation Company (Helicopter)—has seen active service in Korea. Meanwhile, the Army has set up a "procurement programme" for the period 1953-1959, under which sufficient large helicopters will be bought to equip 12 full battalions, with 67 aircraft per battalion. These will be assigned on the basis of one company to each Army division, and one battalion (of three companies plus a H.Q. and service company) to each corps. The overall plan provides for training requirements and attrition losses. At the same time, training programmes have gone ahead to provide flying and maintenance personnel as needed.

As stated, the first company was activated in November 1950. The first operational mission took place the following August, and various exercises have since been carried out involving operations in various types of climate and local conditions. The 6th company arrived in the Far East early last year, and was followed by a second company last summer. While in Korea, the units were required to perform six major movements: two involved troop movements while the remainder were concerned with logistic supply. In each operation, the combat commanders were highly delighted with the results and major problems did not arise. As a result, the army field commander now looks upon the helicopter as just another mode of transport, integrated into normal transport movement-control channels.

Throughout the missions described below the predominant helicopter is the Sikorsky H-19 (or S-55) which is illustrated on these pages. Powered by a Pratt and Whitney engine of 600 h.p. or a Wright engine of 800 h.p., this aircraft has a "brochure" capacity of eight troops, six litters, or a maximum of 1,500 lb of cargo, which can be carried over a distance of some 100 miles at a conservative gross weight of 6,835 lb. The maximum useful load is 3,033 lb, which gives a range of 400 miles, or 1,000 miles with extra tankage. The normal cruising speed is 80 to 86 m.p.h., with a fuel consumption of 31 Imp. gal/hr.

In actual service, the H-19 could be relied upon to bring a mean of two tons into the front line for each hour that the aircraft was at work. Of the 20 aircraft assigned to a company, 12 (or 57 per cent) were normally available at any time.

During operational missions, the average daily flight time was four hours per aircraft—a quarter-hour more than in the service of New York Airways, who operate civil S-55s. On the other hand, the unit was unable, with present H-19s, to move a combat-equipped infantry rifle company in one lift; this largely resulted from optimistic expectations of the individual aircraft performance and availability, but was also influenced by the arduous conditions experienced. It was very soon realized that helicopter movements demand careful planning in advance and, in particular, the closest liaison between the commander, the helicopter unit, the supported unit and the supplier.

The effect on tactics is very slight; but, as the local commander gains experience of, and confidence in, helicopters, so will he be enabled to take bolder and more timely and decisive action in the field. With currently available helicopters, a front-line infantry regiment can receive all its supplies by air. This holds good over extended periods; in Korea, support was sometimes maintained for as long as one month. The only real weakness of the H-19 was its inability to lift vehicles—a shortcoming which is answered by later aircraft.

The employment of cargo helicopters in Korea was not, of course, limited to the U.S. Army; the Air Force and, in particular, the Marine Corps, have had such aircraft in that theatre for over two years. An especially notable operation was recently carried out by Army and Marine Corps' helicopters flying side-by-side, in which over 6,000 neutral

THE MARINE CORPS: This HRS-3 is landing a rocket launcher and ammunition for the 11th Marine regiment just behind the Korean front line. After one salvo, the launcher is rested.

THE ARMY: Two H-19s of the U.S. Army can lift a 75mm howitzer and crew; this machine is taking the gun. Later helicopters will be able to lift artillery, crews, vehicles and ammunition.

Indian troops were "trucked" from a carrier in Inchon harbour to the Panmunjom area. Even more recently, helicopters were used to move equipment for the construction of bunkers in sites previously considered quite inaccessible.

The report *Army Helicopters* discusses the very limited carrying capacity of the present equipment (in actual practice, the H-19s were limited to 1,000 lb per lift) and goes on to give an outline of what the aircraft now on order would do. These machines would have more than three times the carrying capability of the H-19, would be twin-engined (or multi-engined) and one helicopter company would move an entire infantry company, complete with their ground vehicles. In fact, the possibility of lifting heavy weapons makes feasible complete battalion combat teams entirely independent of surface communications. But the employment of the new helicopters would require more exacting supervision, and would increase technical support and maintenance requirements.

Among the conclusions arrived at are some relating to convertiplanes (aircraft capable of hovering, but fitted with airscrews and fixed wings for forward flight). The most definite statement is made that a satisfactory, large-capacity convertiplane is still, contrary to opinion five years ago, at least five years away. Moreover, such an aircraft is now considered the ideal replacement for present assault transport; its development will, therefore, concentrate on medium-range applications, leaving the helicopter still bearing the loads over short ranges. Other conclusions are that the "ideal" army helicopter is still some 10 years distant, and that such a machine would be big, rugged and simple.

Owing to their heavy responsibilities, U.S. Army helicopter pilots are, as far as possible, passed out in a newly authorized warrant officer grade. After qualification they serve 36 months. The helicopter maintenance man, on the other hand, is not required to make any Service commitment; consequently, the turnover of such personnel is high, particularly as civil jobs in this field pay high salaries.

The following is an analysis of operations—one early and one more recent—undertaken by U.S. Army helicopters in the period under review.

EXERCISE: Southern Pine; Date, 13-17th August, 1951; Unit, 6th Transportation Helicopter Company; Personnel, Officers (Aviators) 9; Enlisted men 42; Equipment, 7 Hiller H-23s; Mission: (1) Provide helicopter medical evacuation; (2) Helicopter resupply (emergency cargo); (3) Personnel transport.

Operational Data: Planning consisted of phasing the helicopter company into the already established manoeuvre plan. Evacuation requests went direct to the helicopter company from the division surgeon and evacuation hospital. They were never co-ordinated with tactical or logistic personnel prior to commitment. A plan was prepared to perform a helicopter resupply problem to supply a cut-off battalion for one day. This plan was never implemented. Helicopter operations: Percentage of availability 93.6 per cent; supplies hauled (actual) 1,055 lb, (simulated) 1,200 lb; passengers hauled (administrative purposes) 90, (other administrative flights) 52; actual casualties evacuated 307; simulated casualties evacuated 145; total hours flown 391:45; consumption: petrol 5,531 U.S. gal; oil 273 quarts; grease 19 lb.

Conclusions: Insufficient time for prior planning for complete integration into manoeuvre play. Radio equipment of greater range capability than the ACR 608 and SCR 619 is required. Certain doctrine considerations were violated because of emergency for medical evacuations. Helicopter operations were not properly umpired. Supply channels for spare parts must be expedited. Maintenance support (organizational and field) was inadequate. Radio field maintenance facilities for aircraft signal equipment were non-existent.

Recommendations: Planning for manoeuvres, where helicopter units are to be employed, should provide for typical helicopter company missions. A qualified officer on helicopter employment be assigned to the manoeuvre planning staff. Qualified personnel be assigned to the umpire staff to umpire helicopter operations. That more reliable communications be established.

Lessons Learned: A supply problem need not interfere with evacuation since return trips may be utilized. If supplies or equipment are not moved on forward flights transportation is wasted (medical evacuation mission). Planning must be thorough and realistic. More reliable radio equipment must be developed. Sufficient spare parts and supplies must be readily available or on hand for the duration of the manoeuvre period. Adequate maintenance support must be provided.

EXERCISE: Sky-way (Korea); Date, 25-27th June, 1953; Unit, 6th Transportation Company (Helicopter); Equipment, Fourteen Sikorsky H-19s; Mission, Logistical support for three Infantry Brigades of the 1st Commonwealth Division U.K. to test the extent to which support could be maintained under conditions where all other forms of transportation were impossible and to test the dependability of helicopters in a sustained effort.

Operational Data: Unloading points were marked with large yellow boards placed in such a manner as to designate the number of that particular unloading site. Flight routes were afforded as much defilade as possible. Procedures developed in Skyhook and Skyhook 1 were used. Initial flights to loading and unloading areas carried signalmen and ground crew supervisors. Because of the high temperature and humidity, loads were reduced as much as 200 lb for safety reasons. Planning was conducted using a daily requirement of 228 tons. (This turned out to be too high.) Totals—Actual:

	25 June	26 June	27 June	Total
Cargo (lb)	373,841	348,110	233,125	955,103
Flights	419	466	306	1,191
Flight time (hours)	85:50	82:55	55:05	223:50
Average hours flight time per helicopter per day				6:12
Average cargo load per flight				875 lb
Average fuel consumption per hour of flight time				37.2 gal

The personnel of the 6th Transportation Helicopter Company were attached to the Division for the operation for Administrative support. POL and ammunition was carried in nets, slung underneath the helicopter while rations were loaded internally. Helicopter flights were flown at a height of 200ft above the ground. Percentage availability of helicopters throughout the operation—92.7 per cent.

Conclusions: The helicopter requires approximately three hours of maintenance after one day's work. The refuel point for helicopters must be near but not part of the loading point. Refuelling time is approximately five minutes. A helicopter company working under ideal weather conditions, on a ten-hour day schedule, can meet the daily tonnage requirement of subsistence, fuel and ammunition supplies for an Infantry Brigade.

Lessons Learned: The experience developed as a result of operation Skyhook and Skyhook 1 proved invaluable, emphasizing once again that experience with helicopter units provides for smoother and more efficient operation. This experience confirmed the fact that one helicopter company is capable of furnishing logistical support to a Division for subsistence, fuel and ammunition supplies for an extended period of time. Weather is a factor which must be considered in planning cargo flow capability of a helicopter unit.

LIBERTY BELL: The striking close-up of the Statue of Liberty—note the spectators in the gallery—was taken by S/L. Jimmy Rush from a Bell 47C helicopter during his recent visit to New York. As recorded on this page, and as the picture above shows, he talked with Prince Bernhard of the Netherlands at a Wings Club party.

HERE AND THERE

Viscount Certification

IT is announced as we go to press that a C.A.A. team will arrive on May 16th to evaluate the Viscount. Their visit, the first step towards American certification of the Viscount, resulted from negotiations between Vickers-Armstrongs and Trans-Caribbean Airways, an American independent airline.

R.Ae.S. Honours

THE Royal Aeronautical Society, it was announced on Tuesday, has awarded honorary fellowship diplomas to Sir A. H. Roy Fedden and Sir Frank Whittle, while the Society's Gold Medal goes to Sir Geoffrey Taylor. Details of these and other awards will be given in *Flight* next week.

Percival Prefix

A CHANGE of name is announced by Percival Aircraft, Ltd., who will in future be known as Hunting Percival Aircraft, Ltd. The change of name will provide more complete identification with the parent Hunting Group.

R.A.F. Viscounts?

THE Italian journal *Alata* reports: "The Viscounts destined for the R.A.F., probably three in number—two to replace the present Royal Vikings—will be 700Ds, and will be powered by the new Dart RDa.6."

Solo to Australia

THIS week Mr. Beverley J. Snook, overseas sales manager of Aerocontacts, Ltd., was due to leave Gatwick on a solo flight to Melbourne, where he will deliver the aircraft—a Proctor 4—to a customer. *En route*, he will call on other customers and contacts. Weather delayed his start, scheduled for last Monday.

Helicopter Association A.G.M.

THE ninth annual general meeting of the Helicopter Association of Great Britain will be held in the library at Londonderry House, 19 Park Lane, London, W.1, next Friday (May 14th) at 5 p.m. The meeting will be followed by the showing of the film *Air Head*, produced by the U.S. Marine Corps in Korea, and on this occasion loaned by Westland Aircraft, Ltd.

Wing-tip Viper

A PRODUCTION Armstrong Siddeley Viper ASV.5 turbojet, of the type specified for the Percival P.84 trainer, is shortly to undergo high-altitude trials mounted on the tip of one wing of Armstrong Siddeley's Sapphire - Canberra WD933 (A.S.M. have another Canberra on other work). Such a mounting has been adopted in several French test-beds. The other wing-tip can either carry a similar turbojet or, as in the case of the Canberra, a counterbalancing weight. The Canberra should be able to test the Viper at altitudes up to about 50,000ft.

ABOUT AIR TRANSPORT

A FORTNIGHT hence—on Friday, May 21st—the annual Commercial Aviation Number of *Flight* will be published. It will include specially illustrated articles of value to airline operators and all others interested in the air-transport industry and its equipment, together with regular news-features.

Ice Airlift

AMONG supplies parachuted into the besieged area at Dien Bien Phu, according to a French High Command report last week, there has been a daily half-ton of ice for use in the hospital camp. Another sidelight on the intensified war in Indo-China comes in a report, from America, that efforts are being made there to recruit at least 1,000 pilots to fly for the French; pay of £9,000 a year is mentioned.

R.A.F. Jet Accident-rate

ASKED by Mr. Beswick (Lab. Uxbridge), for numerical information concerning R.A.F. jet-aircraft accidents during the past two years, Mr. Ward (under-Secretary of State for Air) said in the Commons last week that, in the two years ended February 28th last, 416 such aircraft had been totally destroyed in accidents. Mr. Beswick also asked how many of the accidents were held to have been caused by engine disintegration, and to this Mr. Ward replied "only a very few."

Jimmy Rush in America

DURING his recent visit to America, S/L. James Rush, A.F.C., the 1953 British Air Racing Champion, spoke at New York, Cleveland and Boston on the subject of air racing, and appeared in numerous television and radio programmes. He met many of America's leading pilots, among them Miss Jacqueline Cochran, who holds the women's speed record. His visit to the States was arranged primarily in conjunction with Mr. Fred M. Glass, president of the Wings Club, and Rush attended a reception at the club when the guest of honour was Prince Bernhard of the Netherlands. He also found himself drawn into the St. Patrick's Day parade in New York, flying in a Bell 47C helicopter piloted by Ray Chaisson and taking off from the heliport on the roof of the 86-storey Port Authority building.

Atomic D.Z.

A D.H. RAPIDE owned by the G. Q. Parachute Co. took part in a civil defence exercise in the Chingford, Essex, area last Sunday, dropping supplies to units involved in an "atomic-bomb incident." The pilot was Sir Raymond Quilter, G. Q.'s chairman and managing director.

New U.S.A.F. Commander

Maj-Gen. Wilson.

SUCCESSOR to Maj-Gen. Francis H. Griswold as U.S. 3rd Air Force Commander in the U.K., Maj-Gen. Roscoe C. Wilson arrived at Northolt last Friday. Born in 1905, he learned to fly in the 1920s and, after serving in various formations, was assigned to Wright - Patterson A.F.B. in 1939. Subsequent appointments included that of Chief of Staff of the 316th Bombardment Wing (November 1944) and posts in the offices of the Assistant Chief of Air Staff for Materiel and Supply, the Deputy Commander of the Air Force, and the Deputy Chief of Air Staff for Research and Development. He became Deputy Chief of the Armed Forces Special Weapons Project in July 1947, and in September 1948 was appointed Deputy to the Assistant Deputy Chief of Staff, Operations, for Atomic Energy, since when he has held a succession of senior posts in these spheres of activity.

Roy Nockolds' design to illustrate "Endurance", upon which depends the effective striking power of fleets at sea, the forewarning of attack . . . the safety of aircrews and their aircraft. Endurance is a factor which aircraft designers have long sought to reconcile with high performance; The Double Mamba turboprop has been designed to meet this requirement.

THE DOUBLE MAMBA Basically two Mamba engines side by side driving independent co-axial four-bladed airscrews, the Double Mamba develops 2,950 e.s.h.p. Each unit is entirely separate; neither can be affected by loss of power or injury to the other. Specially designed for deck-landing aircraft,★ the Double Mamba has the power potential, handling qualities and safety factors of a twin-engined aircraft, combined with the fuel economy and stowing facilities of a single installation.

★ *The Fairey Gannet—super-priority for the Royal Navy—is powered by the Double Mamba.*

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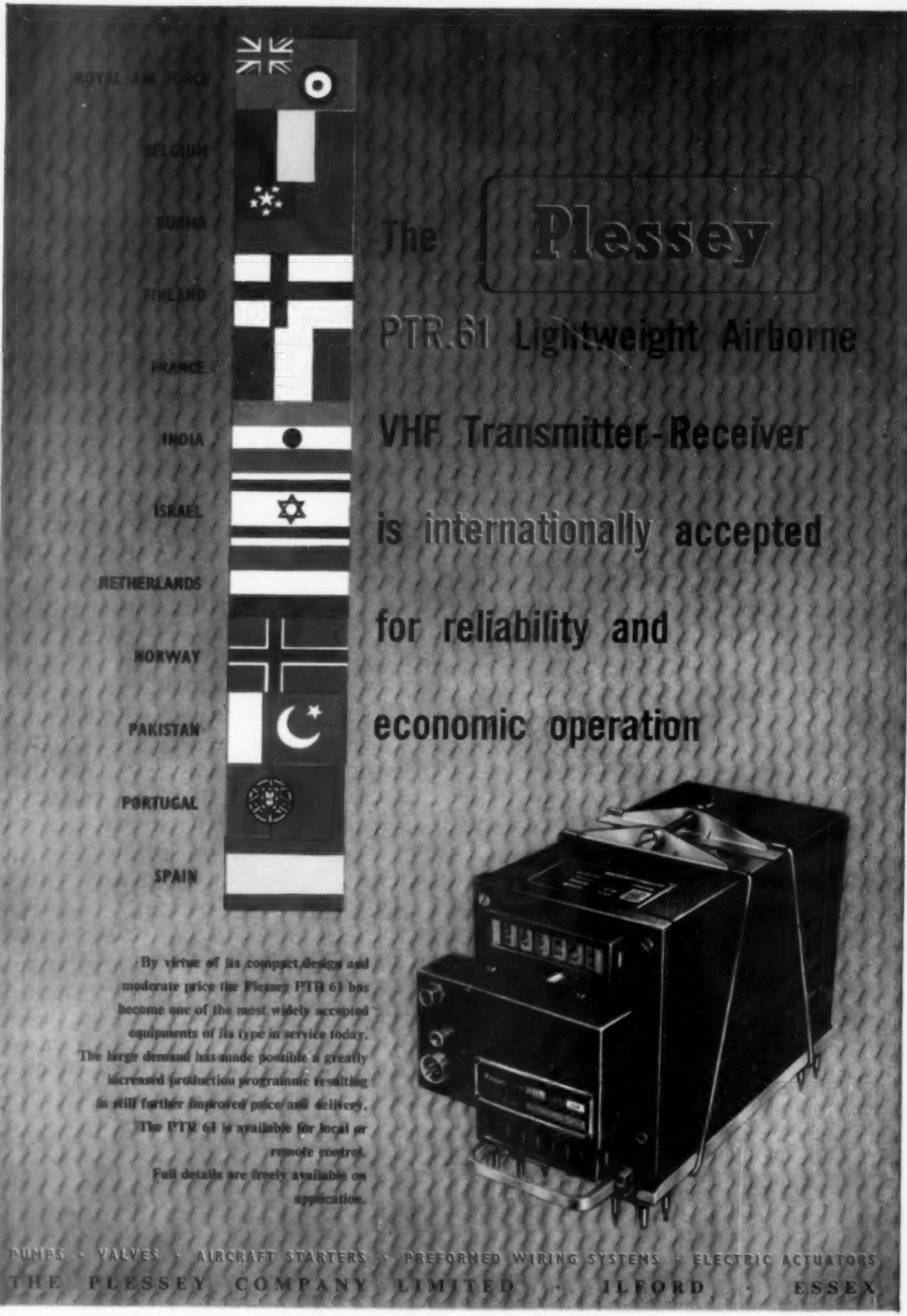
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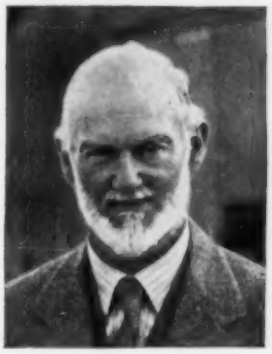
The Hon. C. S. Rolls.

The Two Rs

A Commemorative History of Rolls - Royce Aero Engines

COMPILED BY H. F. KING, M.B.E.



Sir Henry Royce, O.B.E.

TWO men, with the agreeably alliterative names of Rolls and Royce, and with notions and ideals even more happily matched, met in Manchester fifty years ago this month. Rolls—the Hon. Charles Stewart Rolls—possessed wealth, an Eton-and-Cambridge education, a degree in mathematics and applied science, and a fine record as a motorist. He was a sportsman, as distinct from what we should nowadays call a playboy, and he had consistently displayed a manly daring at the wheel and a determined approach to the technical problems of motoring.

In 1894, at the age of 17, he was taken by his father, Lord Llangattock, to France, where the great game and business of motoring was flourishing uninhibited. Having shipped home a 3½ h.p. Peugeot, he drove it to Cambridge in excess of the speed limit—at 4½ m.p.h.—and in 1896, when the man-with-the-red-flag was put out of business, he turned to racing and records.

It was not in his sporting ventures alone that fortune favoured him, but in the business of C. S. Rolls and Co., which he established with Claude Johnson in 1902. In 1903 he set a world speed record of 93 m.p.h.; but the car was a 70 h.p. Mors, and by the following year, when his books showed orders for a hundred fine Continental cars, he could still not find a British product which measured up to his standards.

Henry Royce—the second party to the meeting—had known in his youth none of the luxuries and pleasures which birth had bestowed upon Rolls. At ten years of age he started work as a telegraph boy, later attending a technical college, and serving a few years in the Great Northern locomotive shops at Peterborough. Then, after a spell in an engineering works at Leeds, he set up a business in Manchester, making arc lamps and dynamos. The slump after the Boer War caused him to turn his ambition to cars. Disappointed with a foreign model which he acquired, he decided to put his own ideas into practice, and in 1903 he completed a two-cylinder car of 10 h.p., having handled much of the precision work himself.

One of his first three cars went to Henry Edmunds, a pioneer motorist who had lately become a director of the firm of Royce, Ltd.; and it was he—"the godfather of Rolls-Royce"—who arranged the meeting in Manchester. The two men took to each other immediately, and having tried out Royce's car, young Rolls undertook to sell its maker's entire output. But he was looking much farther ahead than 10 h.p. and two cylinders; he saw before him the golden market of Edwardian England and the engineering perfection that was to link his name with that of Rolls in a monogrammatic symbol of excellence. So he began to ply his partner with suggestions and demands.

The "two Rs" were first officially linked in business association at Christmas 1904, by a working agreement between the two firms; and thenceforth the Rolls-Royce car began the ascent to its long-held pinnacle of fame.

By 1906 Royce's production was large enough to allow Rolls to stop his sales of other makes of car, and Rolls-Royce, Ltd., was founded. Royce's old partner, A. E. Claremont, became chairman; Rolls was technical managing director; Johnson became commercial managing director; and Royce was nominated chief engineer and works director.

While Rolls had been winning the T.T. race, and another at the Empire City track, New York, Royce had been busy with a 40/50 h.p. six-cylinder car, for the Motor Show of 1906. This became the *Silver Ghost*.

Rolls, who had become a member of the Aeronautical Society in 1901, was already a keen balloonist; then, having met the Wright brothers, he turned to heavier-than-air craft. He was awarded his pilot's certificate (No. 2) on March 8th, 1910—the very same day that Lord Brabazon received his No. 1. On the Wright biplane he made the first heavier-than-air crossing of the Channel by an Englishman, and the first double crossing by any aeroplane in history; but soon afterwards—on July 12th, 1910—he crashed to his death at the Bournemouth flying meeting. He was the first Englishman to die in an accident to a powered, heavier-than-air machine.

"Although only 33 years of age," said *Flight*, "Mr. Rolls had already done what it has fallen to the lot of very few men to do, and what only a very small percentage of men are capable of doing, whatever may be their opportunities."

The technical achievements of Royce in aero-engineering are outlined hereafter; the more personal aspects of his career, and that of Rolls, have already been told at length—especially in Harold Nockolds' book *The Magic of a Name*, in *Rolls—Man of Speed*, by Laurence Meynell, and in the monograph *Frederick Henry Royce*, by our late managing editor G. Geoffrey Smith.

In 1910 Royce became seriously ill and thereafter was absent for long periods from his new factory at Derby. He worked on in the south of France and on the south coast of England.

Following the British Schneider victory of 1929—made possible by that masterpiece, the "R" engine—a baronetcy was conferred upon him, and he heard from his bed how an improved engine of this type sent a Supermarine S.6B to final victory in the Schneider Race of 1931. He died on April 22nd, 1933.

Royce shunned publicity ("I am only a mechanic," he would say); but the ensuing record of his company's achievements in aero-engineering alone is some measure of his greatness.

Flight-testing has made a vast contribution to Rolls-Royce successes. Depicted in this "Flight" photograph are a Fairey Battle (Merlin), Hawker High Speed Fury (Goshawk), and Heinkel He 70A (Kestrel).

CHRONOLOGY OF ROLLS-ROYCE AERO-ENGINE DEVELOPMENT

1914 Design of first Rolls-Royce aero engine—later named Eagle—started. Company making engines of official pattern at Derby.

1915 Eagle on test six months after design initiated. Hawk designed and developed. Falcon designed.

1918 Condor on test at 525 h.p.

1919 Alcock and Brown, in a Vickers Vimy (two Rolls-Royce Eagle VIIIs), made first direct crossing of North Atlantic; flying time, 16 hr 12 min. Ross Smith and Keith Smith, in an Eagle-Vimy, made first flight from England to Australia—11,130 miles in 124 hr flying time.

1920 Van Ryneveld and Quintin Brand, also in an Eagle-Vimy, made first flight from England to South Africa—6,281 miles in 92 hr 58 min flying time.

1925 Design of Rolls-Royce "F" series of engines (later called Kestrel) started.

1926 First "F" engine tested and delivered.

1927 The "H" engine—later the Buzzard—under development.

1929 Air Ministry decided in February to compete in Schneider Trophy Contest; Rolls-Royce asked to develop a racing engine. Within six months "R" engine was delivering 1,900 h.p. for a weight of 1,350 lb. Installed in Supermarine S.6, which won Schneider Contest at 328.63 m.p.h.

1931 Rolls-Royce again asked to develop a Schneider Trophy engine to help secure a third victory, which would gain Trophy outright for Gt. Britain. Outcome was improved "R" engine of 2,360 h.p., weighing 1,630 lb. Schneider Trophy won outright. Later "R" engine gave 2,530 h.p. and enabled world speed record to be raised to 407.5 m.p.h.

1932 Design of the P.V.12 engine (later called Merlin) started. (P.V. denoted private venture.)

1934 Merlin completed its first 100 hr run at 790 h.p.

1936 Merlin completed Service Type Test at 975 h.p.

1938 Building of Crewe factory started.

1939 First Merlin built at Crewe. Design and development work started on 37.V.12 engine, later named Griffon. Building of Glasgow factory begun in August.

1940 First Merlin built at Glasgow. First test run of Griffon.

1942 Quantity production of Griffon started.

1943 First Rolls-Royce turbojet—the Welland—passed its 100 hr type test; thrust, 1,700 lb, weight, 850 lb. Design of Derwent I started.

1944 Deliveries of Welland begun, for installation in Gloster Meteor. Design and development of Nene started.

1945 Meteor powered with Derwent Vs broke world air speed record at 606 m.p.h. In September a Meteor was flown with two Rolls-Royce Trent turboprops, being the first turboprop aircraft to fly. By this year power of Merlin had increased to over 2,000 h.p.

1946 World air speed record again broken by a Derwent-Meteor; speed 616 m.p.h.

1947 Pratt and Whitney signed licence agreement for manufacture of Rolls-Royce Nene and Tay. Nenes in production at Derby. Trans-Canada Airlines started operations with Merlin-powered Canadair North Stars.

1948 First public appearance of Avon turbojet at S.B.A.C. Display. Belgium signed licence agreement for manufacture of Derwents.

1949 Dart turboprop type-tested at 1,000 h.p. B.O.A.C. introduced Merlin-powered Argonauts (similar to North Stars).

1950 Australia signed licence agreement to build Nene and Avon. Hispano signed agreement to make Nene and Tay.

1951 English Electric Canberra, with two Rolls-Royce Avons, made first non-stop transatlantic crossing by a jet aircraft—the first of numerous record flights by Avon-Canberras.

1952 Sweden signed licence agreement to build Avon.

1953 Avon-Canberra flew from London Airport to Darwin, Northern Australia, in 22 hr 21 sec. Avon-powered Hawker Hunter established world air speed record of 726.6 m.p.h.; Avon-powered Supermarine Swift later raised record to 735.7 m.p.h. Ministry of Supply opened new factory at East Kilbride, Lanarkshire, to augment production of Avons for the R.A.F. (In addition, Avons were being made by the Bristol Aeroplane Co., Ltd., D. Napier and Son, Ltd., and the Standard Motor Company.)

1954 By May of this year British-built Rolls-Royce gas turbines had completed 2¾ million flying hours; Merlins had completed over 5¼ million flying hours in commercial service. By the end of the year over 185,000 Rolls-Royce piston and gas-turbine engines will have been built.

THE TWO Rs . . .

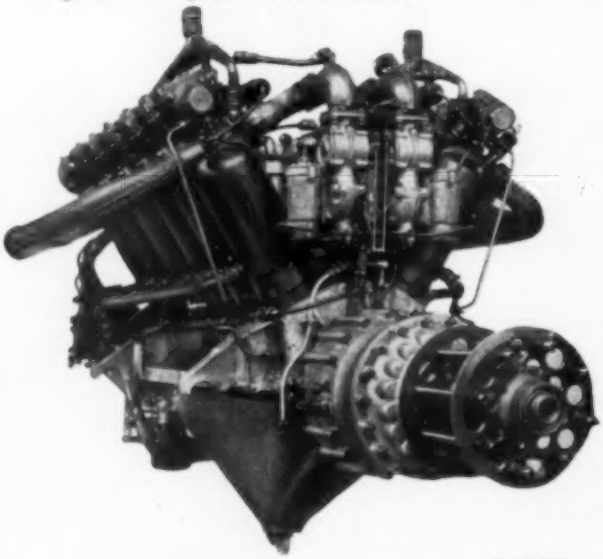
THE EAGLE

A truly historic engine, the Eagle was designed by Henry Royce in collaboration with his chief assistant, A. G. Elliott (now joint managing director and chief engineer). It set the pattern for the smaller Falcon and the larger Condor, and in improved forms continued in service from 1917 until the 1930s.

Though designed for only 200 h.p., the first example was run in October 1915 (less than six months after work on the drawings had been started at Derby) at a brake horsepower of 225; and it may be noted that the present style and title of a certain mechanic who was then in attendance is Lord Hives of Duffield, chairman and joint managing director, Rolls-Royce, Ltd.

By March 1916 the new engine was delivering 266 b.h.p.; by July 284 h.p.; and by December 322 h.p. By September 1917 the figure had risen to 350 h.p.; in Feburary 1918 it had reached 360 h.p. An official Rolls-Royce instruction book dated December 1917 ascribes the following outputs (at normal r.p.m.) to the various series: Eagle I, 225 b.h.p.; Eagle II, 266; Eagle III, 284; Eagle IV, 284; Eagle V, 322; Eagle VI, 322; Eagle VII, 322; and Eagle VIII, 350. These variants differed in the type and number of carburettors, in jet size, in the pattern of inlet pipes and pistons, and other details. By far the most famous among them was the Eagle VIII, which powered such fine aircraft as the Phœnix Cork, Felixstowe F.3 and F.5, the D.H.4, 9A, 9B, 10B and 10C, the Fairey IIIC and IIID, the Handley Page O/400 and V/1500, the Short Shirl, and the Vickers Vimy and Vernon. Other military installations were made in the Wight seaplane, F.E.2D, F.E.4, R.E.7, Porte Baby, F.2, Felixstowe Fury (F.4), D.H.10, Fairey F.16 and F.17 Campania, Handley Page O/100 and Vickers Vim. Civil applications included the D.H.16 and Handley Page W.8b.

Irrespective of series number, the Eagle was a twelve-cylinder, water-cooled, 60-deg vee of 20.32 litres capacity. Each cylinder, with its water-jacket, formed a separate unit; the barrel, machined from a steel forging, was retained by a base flange and studs. Inlet and exhaust ports were machined from solid forgings, welded-in at opposite sides of the head, and the water-jacket was fabricated from steel pressings, welded in place. There was one



Eagle VIII.

inlet and one exhaust valve for each cylinder, and a single camshaft, carried in a casing along each bank of cylinders, operated both. There were two sparking plugs per cylinder, served, on the earlier engines, by four six-cylinder magnetos and on the later series by two twelve-cylinder magnetos.

A contemporary Rolls-Royce description continues: "The oil consumption should be taken as 1 gallon per hour. . . . The lubrication system is of the type in which one oil pump supplies pressure oil to the main bearings and other parts, while one scavenger pump evacuates the accumulation of oil in the crankcase to the oil tank. . . . The quantity of water carried in the

cylinder water-jackets, water pipes, and pump is 3.1 gallons. . . . The Rolls-Royce carburettors are fitted with a control so that the delivery of petrol may be adjusted from the pilot's seat. This not only serves as a means of correcting the effects of decreasing atmospheric pressure with increasing altitude, but can also be used to obtain extremely economical running, and also to obtain a rich mixture for starting. . . . All controls, e.g., throttle, altitude, and magneto, are brought to one common location on the engine, to facilitate connection to the plane. . . . The carburettor throttles are fitted with springs, which, in the event of a breakage of the control, are intended to open the throttles to the full extent."

A special feature of the Eagle was the epicyclic reduction gear, for which the advantage was claimed that it imposed far less strain on the crankcase than would spur gearing. The gear was of fixed sunwheel type, in which an annulus, or internally toothed gearwheel, on the crankshaft meshed with three small spur gearwheels on the extremities of three arms formed integrally with the airscrew shaft. The three small gears were connected to three pinions which meshed with the fixed sunwheel, and the airscrew shaft was bolted to the three-armed spider which carried the planet pinion cage. An Oldham coupling provided the anchorage of the sunwheel to the gear casing and allowed the gears to be perfectly aligned.

Late in 1922 *Flight* reported: "A recent model introduced by Rolls-Royce, Ltd., is the Eagle IX, which is generally similar to the famous Eagle VIII but differs from that type in certain details. The new model has been designed to be equally suitable for peace and war purposes, and to that end the following improvements have been effected:—Two carburettors are fitted instead of four, so that tuning is considerably facilitated. The placing of the carburettors low down allows of using direct-gravity feed; the float feeds have been redesigned. The engine will now function satisfactorily with a 'head' of only 8in above the centre-line of the crankshaft. In view of the tendency in modern commercial aircraft of employing direct-gravity petrol feed from the main tanks in order to avoid pumps, piping, etc., this should be a great advantage, and should help to ensure for the Eagle IX as great popularity as that enjoyed by the previous model."

In the Eagle XV the epicyclic gear was further modified by the insertion of an additional friction clutch and gearwheel in the train, making the existing friction anchorage into a manually controllable clutch and converting the gear from a single-speed to a two-speed type. In the absence of a variable-pitch airscrew this arrangement gave a considerable advantage.

The following data for the Eagle VIII are taken from *Rolls-Royce Aero Engine Instruction Book, Eagle Series I - VIII and Falcon Series I, II and III. Air Board Technical Department Book No. 244, December 1917:* Dry weight, 847 lb; normal r.p.m., 1,800; max. permissible r.p.m. (5 min only), 2,000; gear ratio, 0.60; b.h.p. at normal r.p.m., 350; petrol consumption in gal/hr, at sea level, normal r.p.m. and normal b.h.p., 23; carburettors, four R.R. C.H. (Rolls-Royce, Claudel Hobson), 42 mm; magnetos, four Watford; pistons, high compression, four rings (one at bottom).

In 1925 a little-known Eagle development—the 16-cylinder, 500 h.p. Mk XVI—made its appearance. It had a stroke of 4¾in instead of 6½in. The Mk XX was a projected scaled-up version, but was never built.

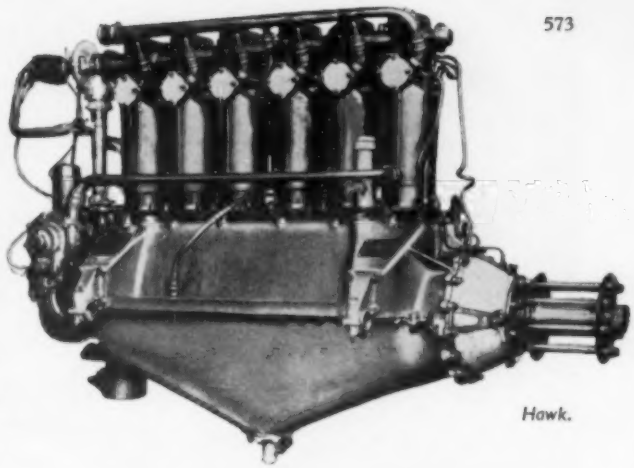
THE HAWK

Originally intended for use in training aircraft, this little engine became far better known as the power-plant of Naval airships. It was designed, in 1915, for an output of 75 h.p. at 1,350 r.p.m., but ratings soon increased. Thus, in February 1916 it was giving 91 h.p.; in October 1918, 94 h.p.; and later in the same month—at 1,500 r.p.m.—105 h.p.

Rarely does an official Service handbook pay tribute to a proprietary article, but in the R.N.A.S. volume dealing with the S.S. Zero airship one reads: "The Rolls-Royce Hawk type engine of 75 h.p. was adopted as possessing a degree of reliability and other properties of particular suitability higher than other makes available."

Of 55,700 hours flown by British airships, 36,000 were put in by Hawk-engined craft. In August 1918 a flight of 50 hr 55 min duration was recorded, and patrols of 23-30 hr were not uncommon. Heavier-than-air machines fitted with the Hawk included the Sage trainer Type III, a few B.E.2Es, and Avro 504Fs.

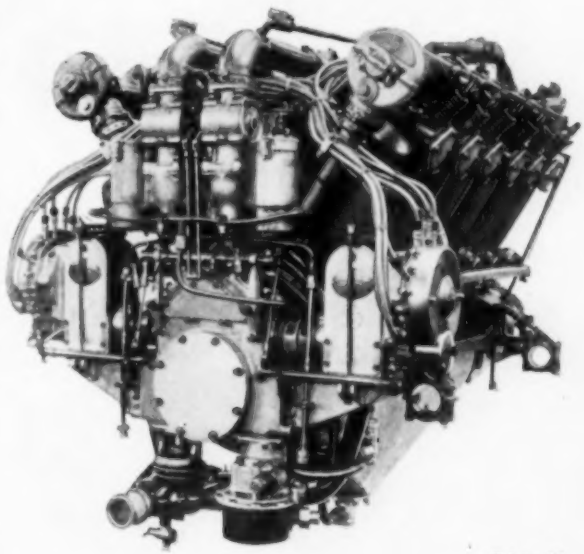
A six-cylinder, ungeared, vertical water-cooled unit, the Hawk had one magneto and one carburettor. Oil consumption was half a gallon an hour. An official Rolls-Royce description ran: "It is usual, when starting this small engine, to turn it by means of the propeller for filling the cylinders after the induction pipes have been primed. The operation of the hand magneto (supplied by Messrs. Rolls-Royce) then starts the engine. The Rolls-Royce Patented Device is supplied for priming. This is



Hawk.

a light and simple apparatus, embodying a hand pump, which can be fixed in any convenient position near the pilot's seat, or as desired. One priming device may serve two or more engines with the use of a change-over cock. When required, a starting handle can be supplied, arranged in line with the crankshaft at the timing gearcase end of engine, and connected thereto by a reduction gear. This apparatus is specially suitable for airship installations."

Data for the Hawk with a nominal output of 100 h.p. at 1,500 r.p.m. were: max. permissible r.p.m., 1,700; fuel consumption at normal power, 6.5 gal/hr; weight, 405 lb.



Falcon III.

THE FALCON

In April 1916 came the Falcon—virtually a scaled-down Eagle. Again ratings increased by leaps and bounds. Thus, in April 1916 the figure was 205 h.p.; in May, 228 h.p.; in February 1917, 247 h.p.; and in April 1917, 262 h.p.—all the foregoing at 1,800 r.p.m. By November 1917 the output had risen to 278 h.p. and by July 1918 to 285 h.p.—in both instances at 2,000 r.p.m. Official data for the Falcon I were: weight, 650 lb; b.h.p. at normal r.p.m., 228; fuel consumption (gal/hr), 16.6. Corresponding figures for the Falcon II were: 665, 255, 18.25, and for the Falcon III (by far the most famous member of the family) 660, 270, and 18.75.

Constructional particulars already given for the Eagle VIII apply generally to the Falcon III. The best-known application of the Falcon was to the Bristol Fighter F.2B, wherein the Series III engine became standard and remained in service until the 1930s. Other British military installations were made in the Martinsyde F.1, F.3 and F.4, R.E. 6 and 7, Armstrong Whitworth F.K.12, Avro 523C and 529 Pike, Blackburn S.P. and G.P. sea-

THE TWO Rs . . .

planes, Kangaroo and Sprat, D.H.4, Fairey F.2, Sopwith tractor triplane, Parnall Perch, improved Short 184, and Vickers Vendace.

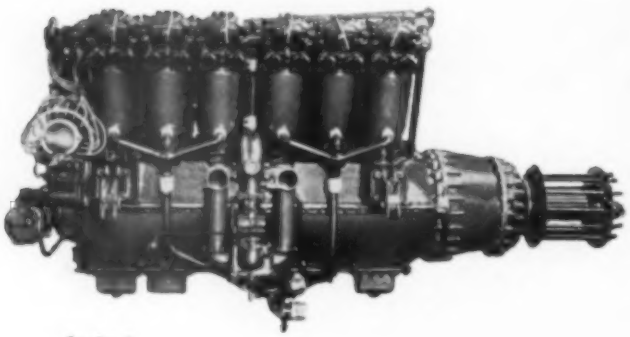
In tribute to the Falcon and the "Brisfit" we reprint these verses from "The Ballad of the Bristol Fighter":—

There are half a dozen buses
On which I've had a whack,
From the R.E.8 to the two-ton weight
Of the lumbering old Nine Ack.

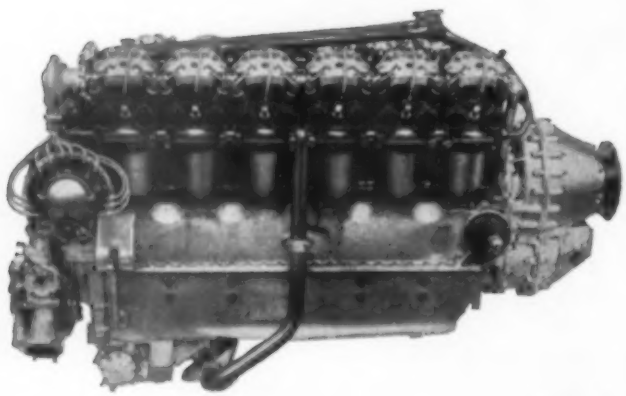
But few of them know the secret
Of making my heart rejoice,
Like a well-rigged Bristol Fighter
With a two-six-five Rolls-Royce.

Is there a sweeter music,
Or a more contented sound,
Than the purring clop of her broad curved prop.,
As it gently ticks around?

Hold her down to a hundred,
Then up in a climbing turn
Till we catch our breath in the air, up high.
I wouldn't exchange my seat, not I,
For a thousand pounds to burn.



Condor I.



Condor III.

THE CONDOR

When it first appeared, in August 1918, the Condor followed very closely the pattern of the Falcon and Eagle, though it was of larger (35 litres) capacity. The Condor Series I was designed for 550/600 h.p., and the larger cylinders necessitated four valves per cylinder instead of two. The valves on each bank were operated by a single camshaft. There were only two carburettors and these were mounted low down on each side of the crankcase in line with the centre bearing. The water pump was transferred to the centre of the engine and an electric starter could be provided.

In succession to the Series I came the IA, wherein the normal output was raised to 650 h.p. at 1,900 r.p.m. There is no record of the Condor II but the Series III, which differed considerably from its predecessors, became very well known indeed, and, like the IA, developed 650 h.p. at 1,900 r.p.m., though it weighed nearly 300 lb less. A notable feature of the Series III was the fitting of a single-spur reduction gear, carried in a housing bolted to the front end of the crankcase. This, as the photograph shows, greatly changed the outline of the engine and made for improved cowling lines. The makers nevertheless recognized that higher stresses were set up in the crankcase than with the old epicyclic type. In the new gear a flange was formed on the front end of the camshaft and to this was bolted an internally toothed ring, the teeth of which engaged with similar teeth on the end of a short hollow shaft. The opposite end of the shaft was formed with splines to transmit the torque to a hollow pinion mounted in roller bearings. Thus, any transverse loads were prevented from being transmitted to the crankshaft from the gearing. The pinion engaged with a toothed wheel mounted on, and keyed to, the airscrew shaft, which was supported on roller bearings and was fitted with a ball-and-thrust bearing to take the thrust of the airscrew. The engine was cleared to use a metal airscrew and an efficient diameter was about 16ft.

Another point of difference between the Condor and the earlier Rolls-Royce engines was in the design of the connecting-rod assembly: whereas in the former engines articulated rods had been used, the Condor had forked rods.

Engines of the Condor III series varied from one another in certain respects, but an Air Ministry description in a publication of 1926 remarks that the various pumps serving the engine had been built into a single unit bolted beneath the crankcase lower half. This unit comprised three oil pumps, a water pump and a petrol pump, the last-named being a unit not previously fitted to any Rolls-Royce engine as a standard component. The description went on: "The carburettor has been redesigned and the altitude control valve is of an entirely new design. Owing to the desire to reduce weight, no hand starting device has been provided, but provision has been made for starting by means of the Bristol gas starter. To this end a gas distributor is provided and is driven from the mechanism contained in the wheelcase."

The Condor IV was a direct-drive engine intended for fighters, and was extensively flown in the Hawker Hornbill, the fastest fighter of its day. The absence of the reduction gearing saved about 80 lb in weight. Normal output was 650 h.p. at 1,900 r.p.m., and dry weight 1,250 lb.

An experimental Condor was fitted with a turbo supercharger running at 26,000 r.p.m., and giving an induction pipe pressure of 13.5 lb/sq in at a height of 2,000ft. It was never flight-tested. The Series VIII, specially designed for internal installation in a projected Supermarine flying-boat, was another development which was not air-tested.

During 1932 it was announced that a compression-ignition version of the Condor had passed the Air Ministry's civil-engine type test of 50 hr and that flight trials were then under way at Farnborough in a Hawker Horsley. The C.I. Condor gave 500 h.p. and weighed, with spares and accessories, 1,504 lb. Conversion was initiated by the Air Ministry and the engine was developed at the Royal Aircraft Establishment with the co-operation of Rolls-Royce, Ltd.

British aircraft powered with the Condor included the Beardmore Inflexible, Avro Aldershot, Ava and Andover, Blackburn Iris I, II and III, D.H. Derby, Fairey Atalanta, Titania and Fremantle, Handley Page Handcross, Hawker Horsley, Saunders-Roe Valkyrie, Short Cromarty and Singapore, Vickers Vixen and Vanguard, and Westland Yeovil.

THE KESTREL

The year 1925 saw the beginnings of a new engine which differed radically from its forebears in having each of the two banks of six cylinders formed from a single aluminium-alloy block. Of 21.24 litres capacity, it was of extremely compact design and first appeared, under the designation F.10, as a direct-drive unit. During June 1927 *Flight* was able to announce that the F.10 had completed its official 100 hr type test at the first attempt, and had been granted a Certificate of Airworthiness. The maximum b.h.p. was 490 at 2,350 r.p.m. and the fuel consumption, at normal power and speed, 30 gal/hr. Dry weight was 760 lb.

In May of the following year *Flight* again reported on the development of the "F" series, introducing the F.12, and describing it as "in a general way the geared version of the F.10." Later, fuller designations and characteristics of the "F" series were made known; thus the F.XIA, F.XIB, F.XIIA and F.XIIB differed with regard to gear ratio and compression ratio; the F.XI engines had a gear ratio of 0.632:1, and the F.XII a ratio of 0.552:1. The letters A and B indicated compression ratios of 6:1 and 7:1 respectively. Subsequently, the F.XIVA and F.XIVB were added to the series; the F.XIV had a gear ratio of 0.475:1.

LONGER RANGE

Flying over thousands of miles of ocean, flocks of wild geese migrate annually from the Arctic regions to the British Isles.

Napier have designed in the Nomad a high-powered aircraft engine of unequalled economy. It is a 12-cylinder 2-stroke diesel compounded with a turbine compressor set, combining the best features of the gas turbine and diesel engine. It will work efficiently on a variety of fuels, and it is not affected by changes in altitude or temperature. The Nomad will give reconnaissance aircraft a greatly increased range and it will enable freight aircraft to carry bigger payloads.

NAPIER Nomad

D. NAPIER AND SON LIMITED, LONDON, W.3.

CDC N2

A page from
THE ESSO HISTOIRE OF AERIAL LOCOMOTION
Adapted from the French de P. Crochet-Damais. Illustrated par Philippe Féty avec permission.

ICARUS AND THE WAXEN WINGS

KING Minos of Crete was exasperated beyond measure by the slow progress of his labyrinth and the appalling inflation of Dædalus's expense account. Mind you, Dædalus was handicapped by building regulations and, no doubt, had trouble with the unions.

Finally the king threw one of his tantrums, seized Dædalus and his son, Icarus, and locked them both in the beastly labyrinth . . . and that might have been the end of the affair. But the building, you will remember, was still incomplete. It had no roof, and Dædalus had only to invent and manufacture a helicopter to win his freedom. Patiently (so Ovid records) the architect and his son set to work: they plucked a thousand chickens and fixed the feathers with linen and wax to two light wooden frames . . .

Dædalus took off first and flew direct and as the crow flies to Sicily, thus breaking the world record for a " heavier-than-air " flight (336 km). But Icarus never made it. Rumour reports that he became intoxicated by his aerial achievement, attacked the height record (2 m.) and got his wings melted by the heat o' the sun. A pity in a way.

Today genius gets results by remembering that it pays to say

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THE TWO Rs . . .

F.10 (later Kestrel).

During 1930 the "F" type engine was named the Kestrel, and yet another system of designation was introduced. The name was followed by the series number I, II or III, indicating 0.632, 0.552 and 0.475 reduction gear ratios respectively; then followed the letters A, B, MS, or S, indicating 6:1 compression, 7:1 compression, medium supercharger, or full supercharger.

As we have said, the most notable design feature of the Kestrel was the adoption of the *monobloc* principle, and this resulted in a very light and rigid engine. The blocks were set at an angle of 60 deg, the cylinder heads, with the necessary inlet and exhaust passages, being cast integrally with the walls forming the water-jackets. Renewable valve-seating rings were screwed into the heads and the valve-guide bushes were of cast iron. The flanged joint between the upper end of the carbon-steel cylinder liner and the head was made gas-tight by a soft aluminium ring, and near the lower end of the liner a sliding watertight joint was formed by means of a rubber ring fitted into a groove in the liner. Just below this joint a flange formed on the liner abutted on the crankcase and the whole assembly was held in position by long bolts. Where these bolts passed through the water space between the liners they were enclosed in aluminium tubes, swaged at the ends to make a watertight joint with the jacket casting. The two inlet and two exhaust valves per cylinder were operated by an overhead camshaft, through a separate rocker for each valve.

The three oil pumps were of the gear type and were driven by spur gearing from the vertical shaft which drove the water pump. Lubrication was on the dry-sump principle.

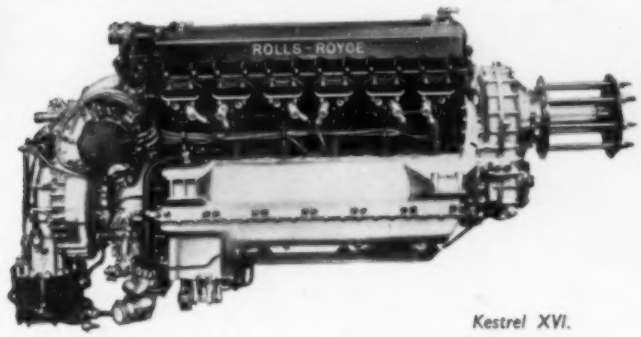
The engine was fitted with hand-starting gear, comprising a worm wheel incorporating a multi-plate clutch mounted on the sleeve carrying the main bevel wheel for the auxiliary drive; the clutch was set to slip when a predetermined torque was exceeded. In the event of backfire also the clutch would slip, thus saving the gears from damage.

In Kestrel engines of the types A and B, two Rolls-Royce Duplex carburettors were mounted between the cylinder blocks. The two throttles of each carburettor were connected by a pair of toothed quadrants, and one quadrant of each pair was mounted on the end of a longitudinal shaft so that all four throttles were opened and closed simultaneously and to the same extent. The carburettors were fitted with a device by which the flow of petrol from the float chamber to the jet was automatically regulated in accordance with altitude.

The supercharger consisted of a high-speed centrifugal fan mounted co-axially with the crankshaft at the rear of the engine and drawing air through the carburettors. The aluminium-alloy impeller, with radial blades, was driven through a speed-multiplying gear comprising a system of three planets. These were frictionally driven from a pinion on the crankshaft by means of slippers, held in engagement with the insides of the gear rims by light springs. As the speed of rotation of the crankshaft—and therefore of the slippers—increased, the radial pressure of these springs was augmented by centrifugal force, and consequently the torque which the planets could transmit increased as the square of the speed. As the torque required to drive the impeller increased at a like rate, the gear was capable of driving the impeller with a predetermined margin of torque above that causing slip, which was constant throughout the working range of speed.

The object of this special friction drive was to protect the gearing against damage on sudden acceleration or deceleration of the crankshaft due to the inertia of the impeller. The impeller inertia, however, in combination with the friction drive, served to damp out torsional oscillations of the shaft which drove the camshaft and auxiliaries, including the supercharger itself.

For all the varieties of Kestrel so far mentioned the normal crankshaft speed was 2,250 r.p.m. and at this speed the unsupercharged low-compression engine developed 490 h.p. at sea level. The unblown high-compression types gave 480 h.p. up to 3,000ft, the medium-supercharged models 525 h.p. at sea level and 500 h.p. at 3,000ft, and the fully supercharged versions 480 h.p. at 11,400ft.



Kestrel XVI.

The next series of Kestrels bore the series numbers IV, V, VI, VII, VIII, IX, X, XI and XII. Of these the IV, V and VI were fully supercharged, with 0.632, 0.553 or 0.477 reduction gear; the VII, VIII and IX were medium supercharged, with the same sequence of gear ratios; and the X, XI and XII were unsupercharged, with a compression ratio of 7:1. The fully supercharged engines were rated at 600 h.p. at 11,000ft, and the medium supercharged and unsupercharged versions at 630 h.p. at 3,000ft and 575 h.p. at sea level respectively.

The ultimate in Kestrel development were the Series XIV, XV and XVI, fully supercharged, but more highly rated than the IV, V and VI. The supercharger ran at 9.4 times the crankshaft speed, whereas on the IV, V and VI it ran at 8.8 times that speed. The rating was 690 h.p. at 2,600 r.p.m. (an increase of 100 r.p.m. over the earlier engines) at 11,000ft, and at 3,000 r.p.m. the output was 745 h.p. at 14,500ft. The weight was 975 lb.

The Kestrel XXX was a later development for training aircraft, and had a rated power of 535 h.p. at 12,500ft.

Kestrels were installed in numerous types of British and foreign aircraft—military and civil. British military applications included the Avro Antelope, Blackburn Nautilus and Sydney, Fairey Fox I, II, III and IV, IIIF, Firefly II and III, Fleetwing, Hendon II and S.9/30, Gloster C.16/28 and Gnatsnapper III, Handley Page Heyford, Hawker Hart, Demon, Fury, Osprey, Nimrod, Audax, High-Speed Fury, Hardy, Hartebeeste and Hind, Miles Master, Parnall Pipit, Saunders-Roe A.10, Short Singapore II and III and Gurnard, Supermarine Southampton, Vickers 141, B.19/27 and 163, and Westland Wizard.

Buzzard.

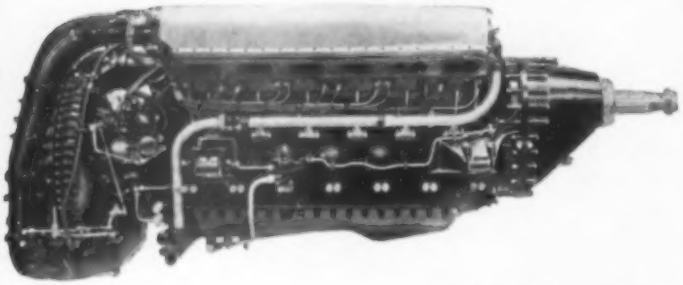
THE BUZZARD

Originally known as the "H" engine, the Buzzard was larger and more powerful than the Kestrel, but very similar in design. In fact, it bore the same relationship to the Kestrel as did the Eagle to the Falcon. The bore and stroke were 6in × 6.6in, and the engine was supplied as standard with a medium supercharger capable of being used to its fullest extent on the ground, so as to give the maximum possible take-off power.

The Series I, II and III engines had reduction gear ratios of 0.632, 0.553 and 0.477 respectively, and the normal power was 825 h.p. at 2,000 r.p.m. at sea level. At 2,300 r.p.m., 955 h.p. was available at sea level. The dry weight was 1,540 lb.

THE TWO Rs . . .

Buzzards were installed in the Blackburn Iris V and VI (Perth), M.1/30 and M.1/30A, Handley Page H.P.46 (M.1/30), Hawker Horsley, Short Singapore I, K.F.I and Sarafand, and Vickers M.1/30.



The "R" engine of 1931.

THE "R" ENGINE

This special racing engine, first developed for the Supermarine S.6s participating in the Schneider Trophy Contest of 1929, epitomized Rolls-Royce excellence, and remains a lofty monument on the road of British aero-engine progress. A development of the Buzzard, and having most moving parts in common with that engine, it differed considerably in appearance, as the picture shows. External modifications—made in order to allow better streamlining—affected the valve covers, cylinder blocks, bottom cover and bearer feet. Auxiliaries were redisposed to reduce the depth, and the length of the reduction-gear housing was increased in order to fine down the cowling lines. The gear itself was of 6 : 1 ratio. A major factor in achieving the output of 1,900 h.p. at 2,900 r.p.m. was an entirely new supercharger.

Notable as was the 1929 model, that produced for the 1931 contest was even more remarkable, for it gave 2,300 h.p. at 3,200 r.p.m. for a weight of only 1,630 lb. This meant that the power had increased 21 per cent for a weight increase of only 6½ per cent—an advance obtained largely by increasing the engine speed, the supercharger gear ratio and the size of the air intake.

With typical caution Rolls-Royce decided that a one-hour run at full power should be the first mark to be passed before the 1931 "R" engines could be delivered as airworthy. By the end of April the early specimens were usually lasting about 20 min before some kind of failure. By the middle of July they would still only do about half an hour non-stop; but on August 3rd a run of 58 min was accomplished at 2,360 h.p., and on August 12th one hour non-stop was completed at 2,350 h.p.

As part of the re-design of the 1931 engine, an entirely new type of connecting rod was developed, and very considerable modifications were effected in the crankshaft and crankcase, to withstand the terrific loads. "Some idea of the magnitude of the crank-chamber stresses," *Flight* remarked, "may be gained from the fact that the load on the centre main bearing due to centrifugal and inertia forces was no less than nine tons. Alternative bearing metals were tried, but white metal was finally made to stand up. An obscure trouble experienced at one time was side-lashing of the big-end bearings against the webs, which caused failure of the white metal on either side of the big ends."

Considerable trouble occurred with valve springs—rather more so than was expected, considering that the speed was raised by only 300 r.p.m.; in fact, at one time two or three would be found broken after a ten-minute run. Extensive tests were run on a valve-spring rig consisting of one cylinder block, and all aspects of design and material were thoroughly reviewed. The springs finally arrived at were somewhat reactionary, but no further failures at all were experienced on the engines after fitting them.

"The oil consumption," *Flight* reported, "rose to terrific figures at the 1931 speeds and powers, partly owing to great quantities lost through the breathers. On one 25-min run the oil consumption was at the rate of 112 gallons an hour; the test house was a sight after it! By weeks of work on combinations of scraper rings and crankcase breathers, by modification of the scavenging system, and by the final adoption of a deeper sump which filled all the available space in the machine, the consumption was reduced to about 14 gallons an hour for the final race engines. It also effected a considerable reduction in the oil temperature rise through the engine; oil entered the engine at about 80 deg C and came out at about 140 deg C. The oil used was pure castor."

The fuel to be used was the subject of many tests, for a compromise had to be effected between power and specific consumption. Invaluable assistance was rendered by the Ethyl Export Corporation. The plugs used in both 1929 and 1931 were Lodge Type X170, which gave very little trouble indeed. During the course of development, incidentally, it was found that an actual engine-run was a more severe test of insulation and general performance than anything the plug-makers could impose themselves. It was decided to give all plugs an endurance test in an engine before sending them to Calshot. After this run they were returned to the Lodge firm, who examined the inners, repolished them and fitted new outer bodies, before despatching them to Calshot. A few doubtful cases, which might have caused trouble in flight, were found in this way. Actually, no plug troubles of any description were experienced in the air, and the same plugs could be used for warming-up and taxying as for full-throttle flying.

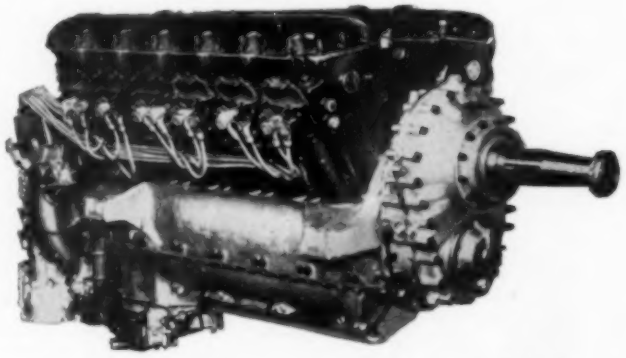
Both B.T.H. and Watford magnetos were used on the race engines. Some trouble was experienced with these on the test-bed, due to the vibration to which they were subjected; consequently every nut on them had to be split-pinned, and certain parts had to be stiffened up.

Before despatch the engines were tested in a hangar with an airscrew fitted. The tick-over speed was set at 475 r.p.m., and the engines were remarkable (as racing units) for their tick-over and flexibility. Once in the aircraft they were started by compressed air or with a Bristol gas starter.

Hiduminium alloys (R.R.50 series) were extensively used and, the life of the engines being short, aluminium-alloy forgings replaced bronze and steel in many parts. From the experience gained from many smashed-up engines, a "life of parts" list was drawn up, and pieces were scrapped after their allotted span, whether broken or not. This procedure was found to be cheaper and quicker than rebuilding smashed engines. There was hardly a single component part in the engine which did not receive design attention and which was not improved in some way—from large units like the crankcase and cylinders down to individual nuts and bolts all over the engine. "It is no exaggeration to say," *Flight* observed, "that five years of normal development work would have been required to cover the same amount of ground."

For short periods powers appreciably greater than 2,350 b.h.p. were obtained from the "R," and on September 9th, 1931, a power of 2,530 h.p. was taken from a "sprint" engine, enabling an S.6B to establish a world record of 407.5 m.p.h.

Engines of the "R" type were used not only in the S.6, S.6A and S.6B seaplanes, but for land-speed records in *Bluebird*, *Speed of the Wind* and *Thunderbolt* and for water-speed records in *Miss England* II and III and *Bluebird* II and III.



Goshawk.

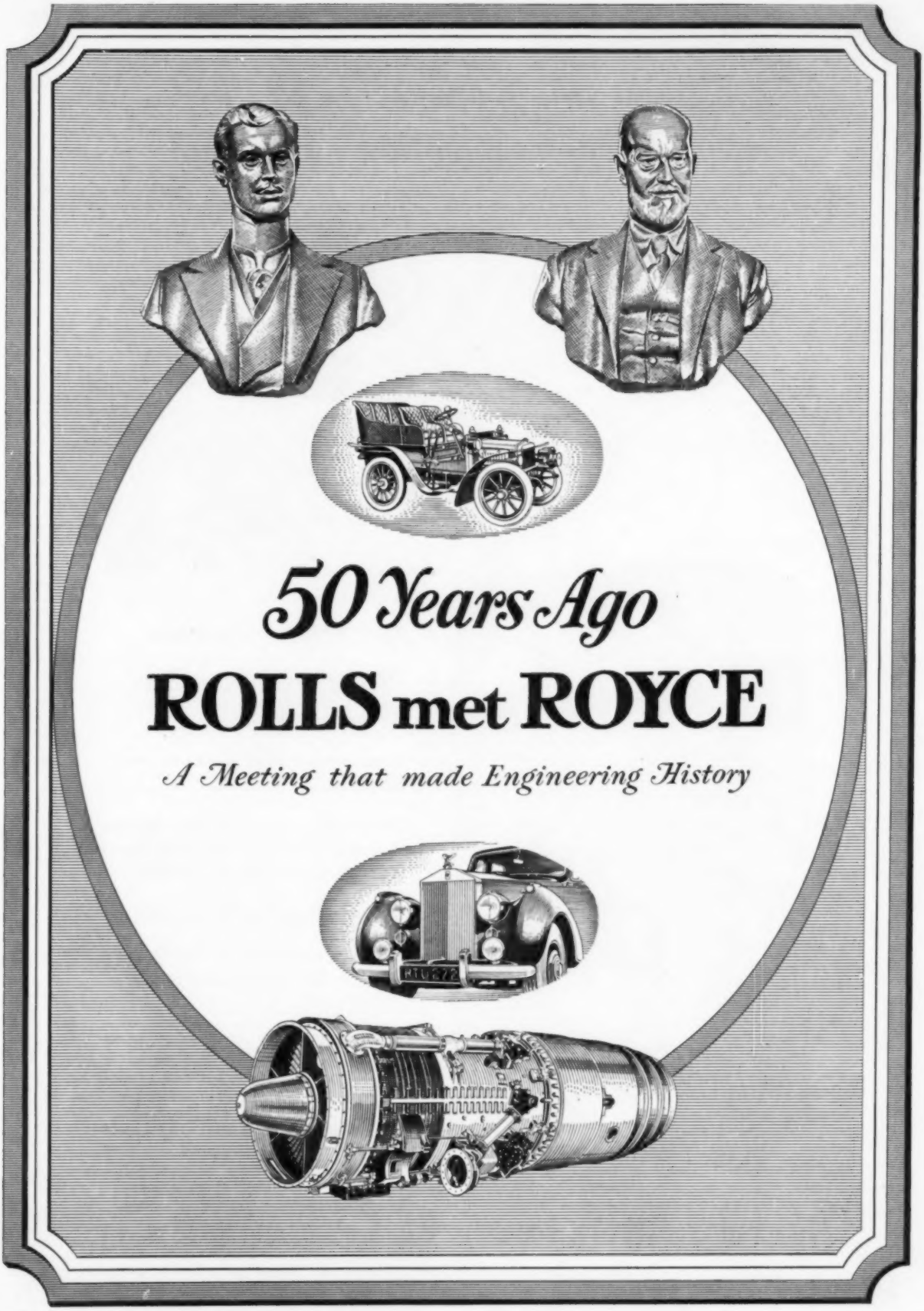
THE GOSHAWK

First announced in 1934, and originally known as the P.V.G., this modified Kestrel paved the way for the development of the Merlin and was designed to be evaporatively cooled. Bore and stroke were the same as for the Kestrel, i.e., 127 mm × 140 mm. Goshawks I, II and III were fully supercharged and gave 600 h.p. at 2,600 r.p.m. at 12,000ft, and 650 h.p. at 15,000ft. The weight was 975 lb, and the three marks had reduction-gear ratios, respectively, of 0.632, 0.533 and 0.477. Goshawks VI, VII and VIII were medium-supercharged units rated at 660 h.p. at 2,600 r.p.m. at 6,000ft, and geared—successively—as the I, II and III.

Only a few Goshawks were built, but they were fitted in the Blackburn F.7/30, Bristol F.7/30, Gloster S.15/33, Hawker High Speed Fury II and P.V.3, Short R.24/31, Supermarine and Westland F.7/30, and Westland Pterodactyl V.

THE MERLIN

Drawings for the P.V.12 engine, as the Merlin was originally called, were begun in January 1933. When the first example was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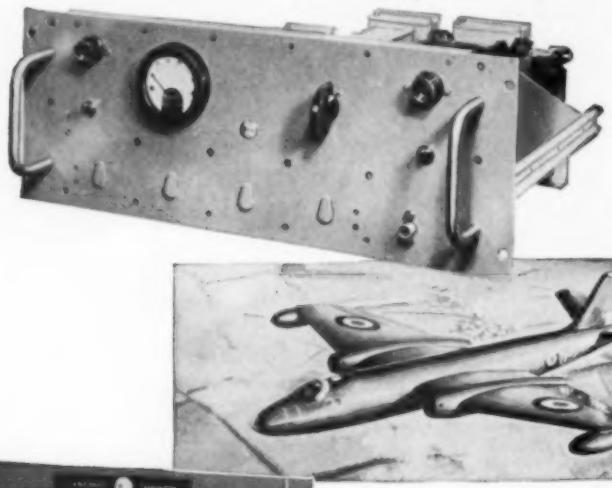
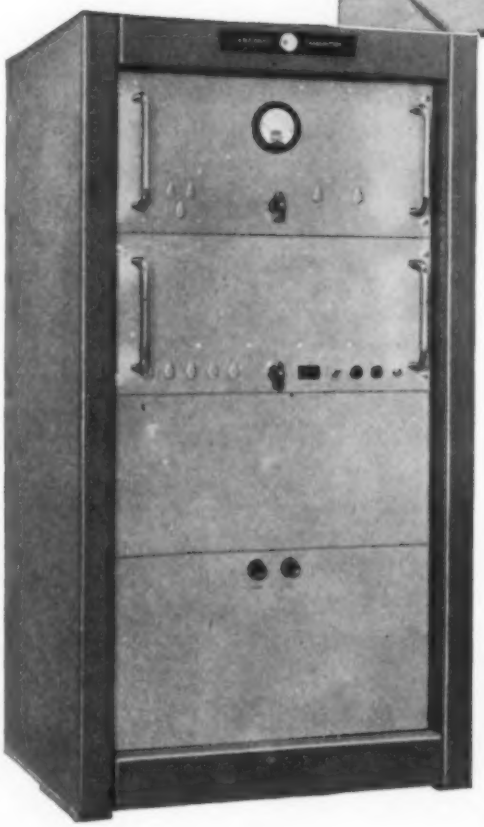
ROLLS met ROYCE
A Meeting that made Engineering History

Ground to air operation by VHF airfield communication equipment





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run on October 15th, a number of weaknesses were revealed, and it was not until July 1934 that a 100-hr type-test could be completed. This first unit gave 625 h.p. at 2,500 r.p.m. for take-off, and 790 h.p. at 12,000ft. Rated boost was plus 2 lb, and weight 1,177 lb.

In *The Magic of a Name*, Harold Nockolds relates how early bench tests resulted in persistent cracking of cylinder jackets and failures of the double-helical reduction gear. The substitution of straight spur-gears cured the reduction-gear trouble, but strengthening of the big integral cylinder blocks and top half of the crankcase was not regarded as the complete answer to the cylinder-jacket defects. Experiments with different types of cylinder heads were made, and the integral cylinder block and upper half of the crankcase were replaced by separate castings for the two components.

The Rolls-Royce engineers then justifiably felt that they were on the right road, but an attempt in 1935 to pass a 50-hr civil type-test with the Merlin C (as the engine incorporating these changes was called) ended in failure, and it was not until December of that year that the test was completed. The rating was 955 b.h.p. at 2,600 r.p.m. at 11,000ft, with a maximum output of 1,045 b.h.p. at 3,000 r.p.m. at 12,000ft, and the engine (Merlin F) was put into production as the Merlin I.

In September 1937 *Flight* published the first description of the Mks I and II, remarking that engines of this series had then flown for over 2,000 hr and that they had shown a marked superiority over the early Kestrels in respect of the rough treatment they would stand. It was disclosed that the chief difference between the Merlin I and II (formerly Merlin G) lay in the cylinder heads. Whereas in the Merlin I these were of the detachable "ramp" type, the Merlin II had blocks and heads cast in a unit, following earlier practice. Both models had four valves per cylinder, each with two concentric return springs. There were two sodium-cooled exhaust valves on the outside of the head and two inlet valves on the inside. On the Merlin II all four were parallel to the centre-line of the block, but the two inlet valves in the detachable head of the Merlin I were inclined at about 45 deg to the exhaust valves. In both engines the latter had phosphor-bronze guides, and high-silicon-chrome steel seatings were screwed into the heads.

A fixed-datum automatic boost regulator maintained a constant induction-pipe pressure without continual reference to the boost gauge and throttle adjustment.

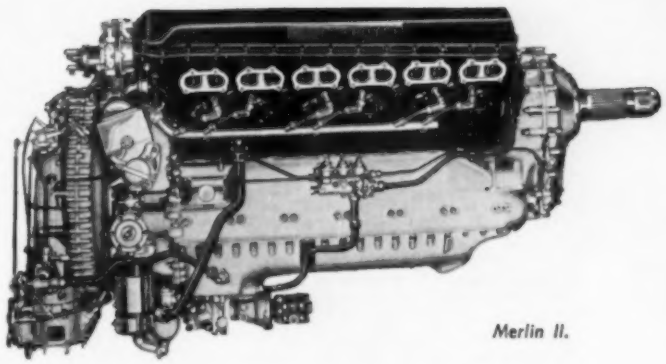
The hollow crankshafts were carried in seven special lead-bronze bearings, and the reduction gear was of 0.477 : 1 ratio. Half the casing for the gearing was cast integrally with the crankcase; in this respect the Merlin differed from the Kestrel. Oil pumps carried on the lower half of the crankcase took their drive from the wheelcase through an idler gear. The dry-sump system was employed, and two scavenge pumps drained the front and rear ends of the crankcase. The pistons and the floating steel gudgeon-pins, which had phosphor-bronze bushes, were splash-lubricated, a baffle in the lower half of the crankcase preventing excess oiling.

Sandwiched between the supercharger and the crankcase at the rear of the engine was a wheelcase from which a full complement of drives was taken. The Rolls-Royce/S.U. carburettor was of the twin-choke tube, updraught type, with a separate diffuser to each choke placed at right angles to the airstream. The semi-automatic, two-stage mixture-control device was operated by air intake pressure, boost and/or a cockpit lever.

International power of the Merlin I and II was 950/990 h.p. at 2,600 r.p.m. at 12,250ft, and the maximum take-off output was 890 h.p. at 2,850 r.p.m.

When some of the first figures for the Merlin were published in *Flight* during May 1937, a note was appended on the development by Rolls-Royce, Ltd., of compact "power plant" assemblies, wherein the mounting was arranged to permit the radiator being carried close to the crankcase. Moreover, by mounting the header tank round the nose of the reduction gear the amount of piping was reduced to a minimum. Advantage was taken of then-recent research in the reduction of cooling drag by enclosing the radiator in a low-drag cowling, wherein the cooling was done by air at relatively low velocity, and from which the flow through the matrix was controlled to suit various flight conditions by an adjustable flap at the exit.

A tribute was paid also to Rolls-Royce's special experimental flight at Hucknall, where, on April 12th, 1935, a P.V.12 engine had first been flown in a Hawker Hart. (Other early machines used at Hucknall were the High Speed Fury II, a Gloster Gnat-snapper, a Hawker Horsley, a Heinkel He 70A, and a Fairey Battle.) "Valuable work in connection with the initial proof tests of new engines, the development of low-drag cooling systems, efficient exhaust systems, and flight problems associated with the use of variable-pitch airscrews, has already been done," it was reported.



Merlin II.

During June 1937 a Merlin II, mounted in a Horsley, began a 400-hr flight endurance test at Farnborough, and a specially rated "racing" engine was developed from it with a view to installation in the special Speed Spitfire, with which an attack on the world's speed record was contemplated. The engine used was a Merlin III, which differed from the Merlin II in having a standardized de Havilland/Rotol airscrew shaft and dual accessory-drive. It was taken from stock and was fitted with strengthened pistons, gudgeon-pins and connecting rods to withstand the extra load. "The power output of the standard engine," writes Harold Nockolds, "was 1,030 b.h.p. at 3,000 r.p.m. at 10,250ft with plus 6¼ lb boost. "Solely by opening the throttle, raising the supercharger pressure, and using fuel of a higher octane," he goes on [the petrol normally used at that time was 87 octane], "the engine was made to develop no less than 2,160 b.h.p. at 3,200 r.p.m. with the supercharger giving 27 lb/sq in boost. This was a phenomenal performance, for it meant that a power-to-weight ratio of 0.621 lb per horsepower had been achieved—a considerable improvement on the 0.71 lb per horsepower of the 1931 R engine.

"This tremendous output, which was admittedly only attained for a short period, nevertheless gave ample proof of the inherent possibilities of the Merlin. But Elliott and Hives were perhaps even more satisfied with a 15-hr endurance run at 1,800 b.h.p., 3,200 r.p.m. and 22 lb boost accomplished during the development period. After this they felt perfectly satisfied that the Merlin would be capable of meeting all the demands that might be made of it. How right they were!"

How right, indeed, for the story of Merlin development we now have to outline is one of the most inspiring in the history of British aero-engineering.

The Merlin II and III were installed in the Spitfire I, Defiant I, Hurricane I, Sea Hurricane I, and Battle I, and were—as will always be remembered—vital factors in the winning of the Battle of Britain. The Merlin IV had pressure-water cooling in place of the glycol cooling of the earlier models, and was developed for installation in the Armstrong Whitworth Whitley IV bomber. The Mk VIII, installed in the Fairey Fulmar I, was a medium-supercharged unit rated at 1,010 h.p. at 2,850 r.p.m. at 6,750ft, and, using 100-octane fuel, delivered 1,080 h.p. at 3,000 r.p.m. for take-off.

The Merlin X—installed in the Halifax I, Wellington II and Whitley V and VII—represented a very important advance in that it had a two-speed supercharger to improve take-off, low-altitude performance during climb or level flight, and fuel economy under cruising conditions. The speed change was effected through an oil-pressure system, the actual changeover under full power taking about a second. In low gear the Merlin X gave 1,145 h.p. at 5,250ft, and in high gear 1,010 h.p. at 17,750ft.

The Merlin XII, driving a Rotol three-blade constant-speed airscrew, was installed in some Spitfire IIs; its maximum output was 1,150 h.p. at 3,000 r.p.m. at 14,000ft and it had a 0.477 : 1 reduction gear.

The next production-type engine was the Merlin XX, which, compared with the X, delivered a greatly increased power at height. The two units were, however, interchangeable. Describing the engine in great detail during 1942, *Flight* remarked: "So far-seeing and gifted were the designers in evolving the original design that the successive types up to the latest and far more powerful Merlin XX remain substantially the same. Even the crankshaft and bearings, the pistons, cylinder blocks, crankcases, are basically the same as in the original conception, though naturally innumerable detail improvements have been effected as constant study and experiment and metallurgical improvements have made possible."

The two-speed supercharger of the Merlin XX was of improved design, incorporating a modified form of central entry which gave a freer flow of air to the blower. The low-gear ratio was 8.15 : 1 and the high gear 9.49 : 1. Amendments were

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also made to the rotating and fixed guide vanes and the improvements mentioned, in conjunction with a larger, twin-choke, updraught S.U. carburettor (designed as a complete, separate unit), gave a marked increase in power. Thus, using 100-octane fuel, the international rating in low gear was 1,240 h.p. at 2,850 r.p.m. at 10,000ft and plus 9 lb/sq in boost; in high gear the figure was 1,175 h.p. at 2,850 r.p.m. at 17,500ft, again at plus 9 lb boost. *Flight* commented: "These figures represent an increase of nearly 250 h.p. over the Merlin II of identical cylinder dimensions, and illustrate in a convincing manner the technical progress achieved by years of 'toil, tears and sweat,' to borrow a classical phrase from our worthy Prime Minister. Nor is the limit of attainment yet in sight." It was further remarked that the achievement of extracting so much extra power from a given cubic capacity had increased the dry weight by only 75 lb, and that over 100 h.p. were being taken from each cylinder. The Merlin XX powered the Beaufighter II, Defiant II, Halifax II and V, Hurricane II and IV, and Lancaster I and III.

Merlins 21, 22, 23, 24 and 25 were all essentially similar to the Merlin XX. The 21 was fitted in the Mosquito I, II, III, IV and VI; the 22 in the Lancaster I and II and the York I; the 23 in the Mosquito I, II, IV, VI, XII and XIII; the 24 in the Lancaster I and III and York I; and the 25 in the Mosquito VI and XIX. Take-off power of the 24 and 25 was 1,620 h.p.

The Merlin 28 was a Packard-built engine, installed in the Lancaster I and III and the Kittyhawk II and known in America as the V-1650-1. When it was disclosed in Great Britain that this American-built engine would differ from its British equivalent in having detachable cylinder heads, it was explained that this form of construction had already been proved satisfactory by Rolls-Royce, Ltd., and would have been adopted by them two years or more previous to the Packard innovation had it not been for the fact that such an important modification would have delayed the attainment of maximum production.

The Merlin 29 was also Packard-built, but had a reduction gear ratio of 0.477 : 1 instead of 0.42 :-1, and was fitted with a splined airscrew shaft; it was fitted in Canadian-built Hurricanes and the Kittyhawk II. Changes from its predecessor were so small that the designation V-1650-1 was retained.

The Merlin 30 was a medium-supercharged engine, installed in the Barracuda I and Fulmar II, and giving 1,240 h.p. at 7,250ft and a take-off output of 1,300 h.p. The Merlin 31 was another Packard V-1650-1 and was mounted in the Canadian Mosquito XX, the Australian Mosquito 40, and the Kittyhawk II. An increase in take-off output from 1,300 h.p. to 1,600 h.p. characterized the Merlin 32, which powered the Barracuda II and Seafire II. The Merlin 33 was yet another Packard-built version, installed in the Mosquito XX and 40, and the 38 (also by Packard) was fitted in the Lancaster I and III. Both the 33 and 38 gave 1,390 h.p. for take-off.

A variant which saw very extensive service was the Merlin 45, fitted in the Spitfire V, P.R.IV and VII, and Seafire II; at 16.000ft and 2,850 r.p.m. its output was 1,200 h.p. The Merlin 45M was rated for duty at lower levels and delivered 1.585 h.p. at 2,750ft; it was fitted in the Spitfire L.F.V. The Merlin 46 and 47 were both high-altitude engines (1,115 h.p. at 19,000ft); the 46 powered the Spitfire V, P.R.IV and VII, and Seafire I, and the 47 (which had a cabin supercharger) found its application in the Spitfire VI. The Merlin 50 was similar to the 45 and was fitted in the Spitfire V; the 50M was almost identical with the 45M and powered the Spitfire L.F.V; the 55 was again like the Merlin 45 and was fitted in the Spitfire V and Seafire III; and the 55M resembled the 45M and was the power unit of the Spitfire L.F.V and Seafire L.F.III.

In March 1940 Rolls-Royce had been asked by the Ministry of Aircraft Production to submit their proposals for increasing the high-altitude output of the Merlin to enable a pressurized development of the Wellington to operate at 40,000ft. An output of 800 h.p. at 40,000ft was estimated to be required. To that end the company set about experimenting with a two-stage supercharger, and an engine with this fitment was bench-tested in April 1941. This became the Merlin 60, which, though installed in Wellington VIs, was soon declared obsolete. Adapted for fighter requirements, however, and designated Merlin 61, the new engine was installed in the Spitfire VII, VIII, IX, and P.R.XI, and gave those fighters a decided "edge" over their German adversaries.

The key feature of the Merlin 61 was its two-speed, two-stage supercharger, with two rotors on a common shaft. The mixture was compressed by the first stage and was delivered to the inlet of the second stage, where it was further compressed before being delivered to the induction pipe. In order to reduce the mixture temperature to a normal figure, a box-like intercooler was interposed between the outlet of the second-stage supercharger and the rear of the cylinder blocks. In a typical Spitfire installation the intercooler radiator was mounted under the port wing in a duct, which also housed one of the main engine-cooling radiators.

The real significance of the Merlin 61 was that at 40,000ft it developed double the power given at a much lower altitude by the Merlin II of 1939/40. Even at 23,500ft its maximum power was 1,390 h.p. The weight had risen to 1,640 lb.

The Merlin 62 was used in the Wellington VI, and the 63 (wherein the maximum output had risen to over 1,650 h.p.) appeared in the Spitfire VII, VIII, IX and P.R.XI. The 64 was similar to the 63 but had a cabin supercharger; it was mounted in the Spitfire VII. The 66 powered the Spitfire L.F.VIII and IX. The 67 had a reduction gear of 0.42 : 1 instead of 0.477 : 1, as had the 63, 64 and 66, and the 68 was a Packard-built model, designated V-1650-3 and installed in the Mustang III. Its take-off output was 1,400 h.p. In the Merlin 69—another Packard-built variant, known in America as the V-1650-7—1,490 h.p. was available for take-off; this engine powered Mustang IIIs and IVs. The Merlin 70 appeared in the Spitfire H.F.VIII and IX and P.R.XI, and the 71 (with cabin blower) in the Spitfire H.F.VII. The Merlin 72 was applied to the Mosquito P.R.IX, XVI and 30, and the Westland Welkin I. Some Mosquito XVIs and Welkin Is had Merlin 73s or 76s. The 76 was the same as the 72, but had a cabin supercharger. Yet another engine for the Mosquito XVI and Welkin I was the 77, with cabin supercharger. In the Merlin 85 the take-off output was increased to 1,635 h.p. This was a bomber engine and was installed in the Lancaster VI and Lincoln I. The Merlin 224 was built by Packard and was the same as the Merlin 24; it was fitted in the Lancaster I and III. The 225 was another Packard-built model used in the Mosquito 25 and 26 and identical with the Merlin 25. The Merlin 266—again Packard-built—was the same as the Merlin 66 and was mounted in the Spitfire L.F.XVI.

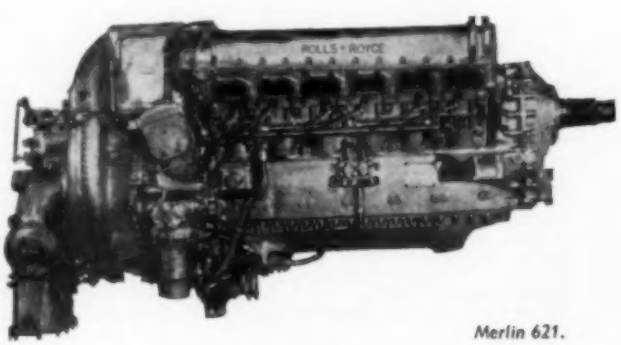
The war being over, and the exigencies of security less restrictive, particulars were released of the Merlin 113 and 114, which became well known as the power plants of Mosquitoes 34, 35 and 36. These engines delivered 1,430 h.p. at 27,250ft with a boost pressure of plus 18 lb. Even more notable were the Merlin 130 and 131, specially "tailored" for the de Havilland Hornet. The installation of these was amazingly clean, and in this connection it may be observed that a steady increase in b.h.p./sq ft of frontal area had been achieved by Rolls-Royce since the days of the Eagle and Falcon. Thus, every four years between the two World Wars an increment of roughly 25 b.h.p./sq ft was attained until 1936. With the advent of the Merlin there was a very decided improvement, amounting to 60 b.h.p./sq ft, continuing until 1940. Between 1940 and 1944 the figure was 100 b.h.p., and in 1945, with the introduction of the Merlin "100" series, 340 b.h.p./sq ft was recorded.

The Merlin 130 and 131 were the first of their family to incorporate downdraught carburettors; and, to eliminate the air scoop as used on the Mosquito, ducted air intakes were faired into the leading edges of the wing. The war-time Bendix/Stromberg carburettor was replaced by a low-pressure fuel-injection system, which delivered through a spray nozzle into the supercharger eye. The 130/131 differed, incidentally, only in being "handed" right and left respectively. The sum total of improvements incorporated in these remarkable engines raised the output to 2,030 h.p. at 1,250ft with a boost of plus 25 lb/sq in.

Another special military Merlin of the post-war years was the 140, developed for the Short Sturgeon and equipped to drive contra-rotating airscrews. Emergency maximum power was 1,650 h.p. at 16,750ft.

As though the foregoing mass of engine designations were not sufficiently bewildering, we now have to record that the latest Merlin to go into service with the R.A.F. and Royal Navy is the 35, a trainer engine developed for the Avro Athena and Boulton Paul Balliol. It has a single-speed supercharger and a maximum take-off output of 1,280 h.p.

Although the Merlin engine will be remembered principally for its military applications, it has achieved in post-war years a



Merlin 621.

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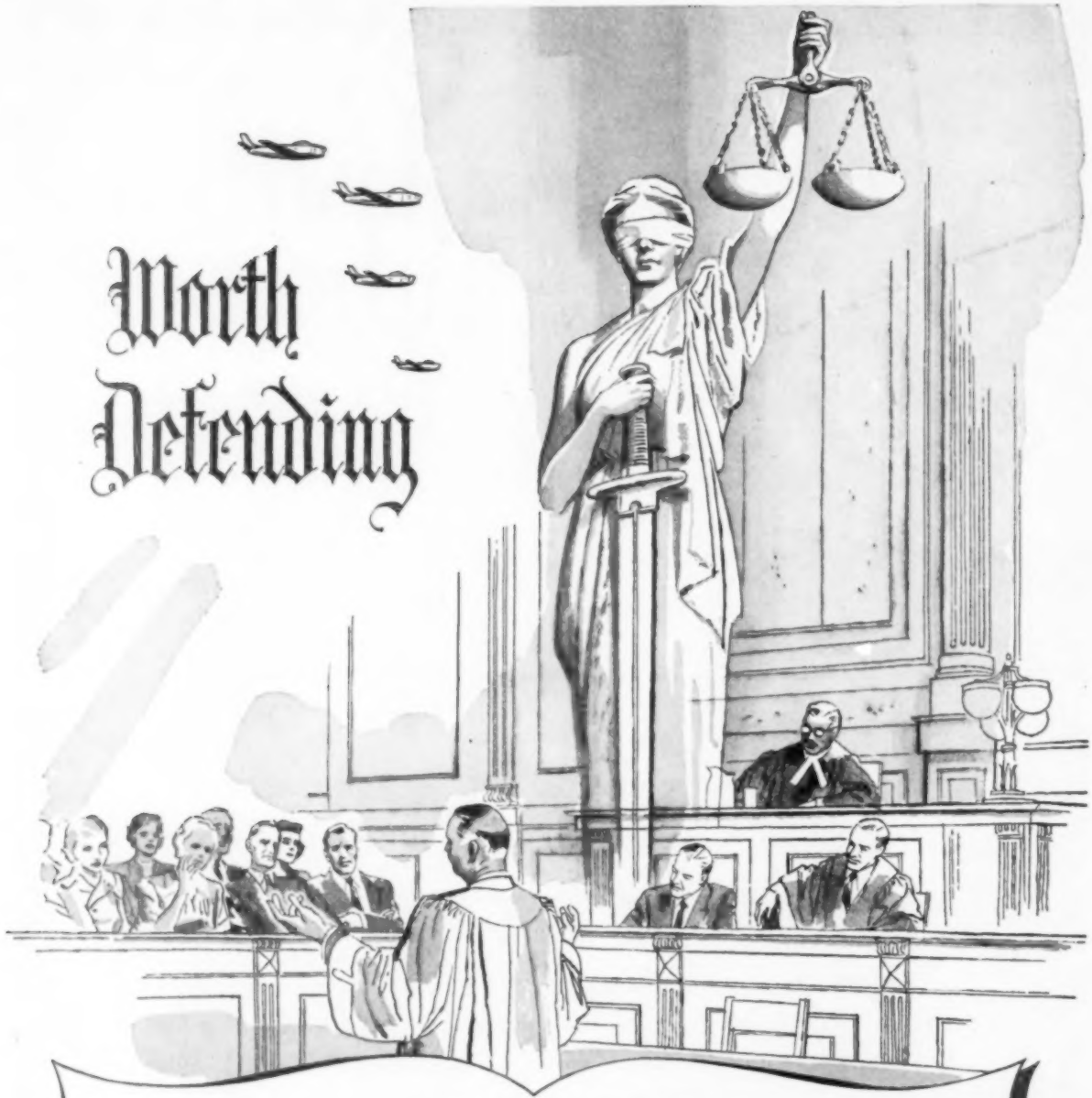

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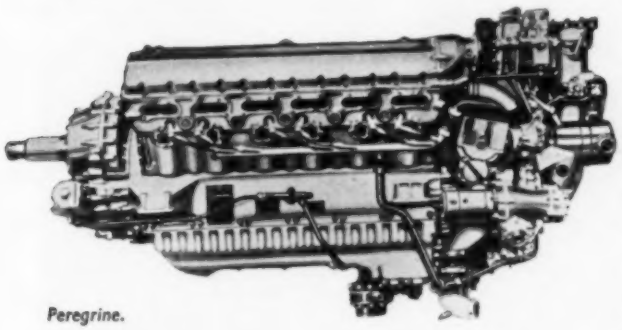
remarkable record in the civil field. The first of the civil Merlins, the 102, was the first to complete successfully the Air Registration Board's type-test requirements for civil aero engines. There followed the 500 series (these were installed in Lancastrians and Yorks), with two-speed, single-stage supercharger, and the 600 series, with two-speed, two-stage supercharger. The 620 was designed specifically for North Atlantic operation and went into service during 1947 in the Canadair North Star airliners of T.C.A. The 600, 620 and 621 series deliver a continuous cruising power of 1,160 h.p. at 23,500ft and 1,725 h.p. for take-off; the 622-626 units have a continuous cruising rating of 1,420 h.p. at 18,700ft, and give 1,760 h.p. for take-off. There are numerous variations between the civil Merlins; thus, the 621 has half intercooling and charge heating; the 722 either full or no intercooling; the 623 half intercooling and charge heating; and the 724 and 724-1C either full or no intercooling. Installations include: Merlin 621, Avro Tudor II and IV; 722, T.C.A. Canadair North Star; 623, Tudor IVB and V; 724, T.C.A. North Star; 724-1C, B.O.A.C. Argonaut (Canadair Four).

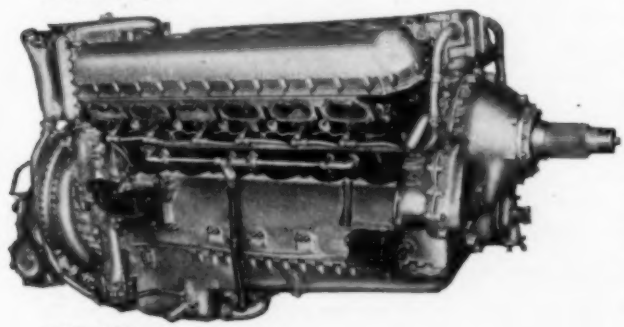


Peregrine.

THE PEREGRINE

The Peregrine was developed during 1939 from the Kestrel. Running on 87 octane fuel, it had an international rating of 860 h.p. at 2,850 r.p.m. at 13,500ft, and a maximum output of 885 h.p. at 3,000 r.p.m. at 15,000ft. A number of Merlin features were incorporated and provision was made for a wide range of auxiliaries. External differences from the Kestrel included the fitting of a downdraught carburettor; this had progressive boost control, in which the "dead" range of movement of the throttle lever was eliminated.

Peregrines were installed in the Westland Whirlwind and Gloster F.9/37.



Griffon 130.

THE GRIFFON

It is not perhaps generally realized that the Griffon 37.V.12 was originally developed to meet Fleet Air Arm requirements—specifically, to give high powers at low altitudes and thus to be suitable for installation in torpedo-bombers. The decision to go ahead with it was taken in December 1939, and it was recognized that the same basic engine should be suitable for installation in existing fighters, then powered with the Merlin. Dimensions and configuration were planned accordingly.

Relative frontal areas were 7.5 sq ft and 7.9 sq ft. "It would seem well-nigh impossible," *Flight* remarked, when describing the Griffon for the first time, "that with such similarity of overall dimensions in two engines of the same basic type the swept volume of one should be 35.9 per cent larger than that of the other. Such, however, is the case. Piston area of the Griffon is 23 per cent greater than that of the Merlin, this having been achieved by increasing the cylinder bore to 6in, a figure which is just about verging on the optimum limit."

Though following Merlin lines, the Griffon differed very extensively in detail design. A prominent innovation was the taking of the camshaft and magneto drives from the front; this was decided upon in order to reduce torsional vibration in the camshaft drive. By interpolating a semi-floating coupling between the crankshaft and the driving wheel of the reduction gearing, and, in addition, by taking the cam drives from the airscrew-driving gear, angular variations in crankshaft speed were greatly reduced in their transmission to the camshafts.

"Perhaps the most novel feature of the crank assembly," *Flight* commented, "is that the main bearings and big ends are all lubricated from the hollow interior of the shaft. This scheme, though novel, is by no means new, Rolls having first tried it years ago; however, the Griffon is the first Rolls engine in which it has become practice."

Early Griffons—the II, III and IV—had two-speed, single-stage blowers, and gave a maximum power of 1,735 h.p. at 16,000ft and 1,495 h.p. at 14,500ft. For take-off 1,720 h.p. was available. These engines differed in reduction gear ratio, the II and III being geared 0.451:1, and the 4, 0.510:1. Until superseded by the Griffon XII the series II engine was installed in the Firefly I and II; the Griffon III and IV were mounted in the clipped-wing Spitfire XII—specially developed to tackle the Fw 190 at low and medium levels. By increasing boost pressure to 15 lb/sq in the take-off power of the Griffon VI was raised to 1,815 h.p.—an increment of importance in that this engine powered the Seafire XV and XVII carrier-borne fighters. The Griffon XII resembled the VI except in supercharger and reduction gear ratios; it delivered 1,645 h.p. at 11,500ft.

The system of designating the two-stage supercharged Merlins with series numbers beginning with 6 was also adopted for the Griffon range. For a weight increase of 290 lb, accounted for by the new blower system, the Griffon 61 delivered 2,035 h.p. at 7,000ft and 1,820 h.p. at 21,000ft; its most famous application was in the Spitfire 21. Identical in all but reduction gear, the Griffon 65 powered the Spitfire XIV, and the Griffon 66 was again similar but had a cabin supercharger for P.R. work in the Spitfire XIX. Griffons 64 and 67 were derived, respectively, from the 61 and 64, and gave no less than 2,375 h.p. at 1,250ft, and 2,145 h.p. at 15,500ft; the 64 powered the Spitfire 21 and Seafire 46, and the 67 appeared in the Spitfire XIV.

Though early examples of the Vickers-Supermarine Spiteful had the Griffon 61, the production model had the Griffon 69, the maximum power of which exceeded that of the earlier two-stage Griffons by some 300 h.p., with no increase in weight. This meant that each cylinder was developing something approaching 200 b.h.p. Official maximum powers were 2,375 h.p. at 1,250ft in M.S. gear, and 2,130 h.p. at 15,500ft in F.S. gear. Boost pressure was plus 25 lb/sq in, made possible by 150 grade fuel.

Griffons 72 and 74 were further developments of the 65 for the Fleet Air Arm; they delivered 2,245 h.p. at 9,250ft. The 74 was distinguished from the 72 in having a Rolls-Royce injection pump instead of the Rolls-Royce Bendix/Stromberg carburettor. These engines were, respectively, the power plants of the prototype Firefly IV and production Fireflies of the same mark.

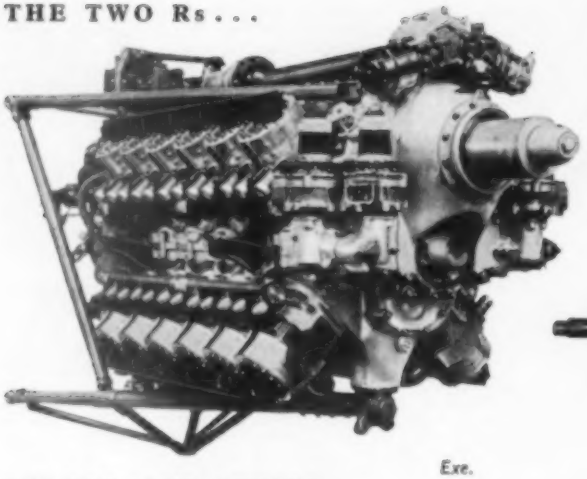
An innovation of more than usual interest was the adoption, on the Griffon 85, of a drive for contra-rotating airscrews; this engine appeared in the Spitfire XIV, 21 and Seafire 45. The Griffon 87 was a further development, rated at 2,145 h.p. maximum at 15,500ft, and the 88 differed only in having an injection pump. "Contraprop" Griffons, of the 85, 87 and 88 series, were mounted in the Spitfire XIV and 21, and Seafire 45 and 47.

For the Barracuda V Rolls-Royce developed the Griffon 37, with a modified two-speed, single-stage blower, maintaining 18 lb/sq in boost in either gear. Though the Barracuda was thus provided with no less than 2,055 h.p. at 2,250ft, only Merlin-powered machines of this type went into squadron service.

Perhaps the most impressive of all Griffon developments was the three-stage supercharger incorporated in the 101 series, together with Rolls-Royce fuel injection. The new blower made possible an output of over 2,000 h.p. up to 20,000ft—with no increase in dimensions. Weight rose by a mere 40 lb.

Notable among post-war developments is the Griffon 67, for use in long-range Service aircraft and having provision for contra-rotating airscrews. On this engine water/methanol injection is automatically brought into play when the boost pressure for the standard fuel approaches maximum value. The controlling unit works in conjunction with the boost control and progressively increases the flow of water methanol with boost pressures from 18½ to 25 lb/sq in. Contraprop Griffons power the Avro Shackleton maritime-reconnaissance aircraft. Other variants of the Griffon are serving in the numerous marks of Fairey Firefly.

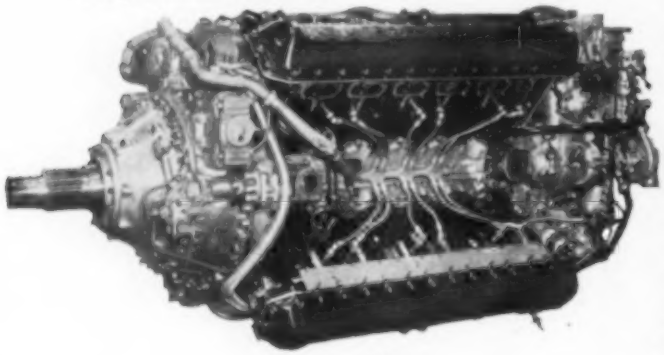
THE TWO Rs . . .



Exe.

THE EXE—AND OTHERS

The first Rolls-Royce engine to be named after a river, as are the modern turbojets, was this experimental unit, which was notable in having sleeve valves and pressure-air cooling. Its 24 cylinders were arranged in X form, in four banks of six, and the capacity was 22 litres. Rated output was 1,200 h.p. at 4,000ft. The Exe—a rare picture of which appears herewith—was test-flown in a Fairey Battle during 1938, but the project was shelved when it became clear that the company's main productive capacity must be devoted to the Merlin. Another experimental unit related to the Exe was the Pennine, and it may be noted here that in the years preceding the war Rolls-Royce were experimenting with two-stroke as well as four-stroke engines, and continued the compression-ignition experiments started with the Condor. The H layout was also examined.



Vulture.

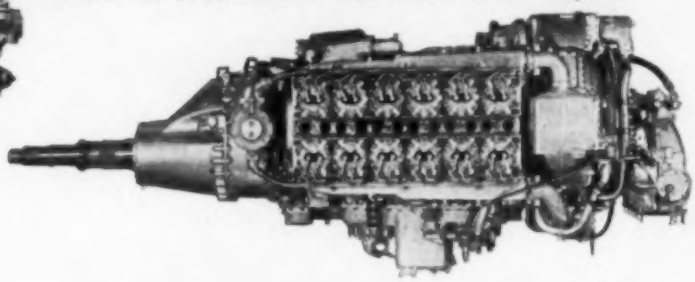
THE VULTURE

This liquid-cooled engine had its 24 cylinders arranged, in four banks of six, again in the form of an X, and may be considered as two Kestrel-size units with a common crankshaft. It was test-flown in a modified Hawker Henley and was used on operations in Avro Manchester bombers, though various troubles, and the desirability of concentrating on the Merlin and Griffon, led to discontinuance of development. (The basic Manchester airframe, with four Merlins in place of two Vultures, of course, became the splendidly successful Lancaster.) The Vulture was also installed in the Hawker Tornado fighter and Vickers-Armstrongs Warwick bomber.

Few details of the engine were ever released, but when it was first described in *Flight*, in June 1942, it was noted that the capacity was 2,592 cu in. Maximum power ratings were 1,845 h.p. at 3,000 r.p.m. at 5,000ft in low gear, and 1,710 h.p. at 3,000 r.p.m. at 15,000ft in high gear. Detail construction followed previous practice in that light-alloy cylinder blocks, head and coolant jacket were employed, with "wet" cylinder liners of steel. The crankshaft was carried in seven bearings. Each cylinder had four valves, operated by overhead camshaft, and two sparking plugs; there were two independent screened magnetos. Variable-datum automatic boost control, with two-position mixture control, was used in conjunction with an S.U. twin-choke, down draught carburettor, and there were two vertical air intakes, coupled by a single entry. The two-speed supercharger delivered mixture to two trunk pipes, each feeding two blocks of cylinders.

EAGLE THE SECOND

The illustrious and wholly fitting name of the first Rolls-Royce aero engine was revived for this, the last of the great line of reciprocating, liquid-cooled units. Reviewing design factors that decided the form of this magnificent piece of engineering *Flight* remarked: "The initial design project was conceived toward the end of 1942 as the necessity for a higher-powered engine was foreseen. Considerations of aspiration and flame travel set a more or less effective limit of about 6 inches to bore size, and



Eagle.

with cylinders of this order it has been established that 12 pistons per crankshaft is about the practical limit. Thus a twin-crankshaft engine was necessary, and the disposition of the cylinders in a flat-H followed naturally, since far and away the best installation case is met by this layout.

"Sleeve valves were decided upon in view of the fact that they undoubtedly offer advantages over poppet valves from the aspect of maintenance and obviation of adjustment; and whilst no one would be so reckless as to suggest that the poppet valve has reached the ultimate peak of development, it is not far short of the summit and its limitations are very well known."

Our description of the engine continued: "The case is split vertically into port and starboard halves of cast light alloy—and a beautiful piece of work it is—with seven bearings for each crankshaft carried in lateral webs axially stiffened by integral intercostal bracing in each half. . . . The front end of the crankcase is double-walled with approximately a 2in cavity, the inner wall housing the No. 1 main bearings of each crankshaft, and the front wall carrying the tail bearings for the timing gears uniting the crankshafts.

"Cylinder blocks are also very fine examples of sandcasting technique in light alloy, the upper and lower rows of cylinders on each side being formed in one casting. Each cylinder is ventilated with three inlet and two exhaust ports, the latter ports of each vertical pair of cylinders discharging to a common pair of ejector stacks.

"Sleeve drive is by a worm shaft on each side commonly serving top and bottom rows of sleeves, each shaft running in six split plain bearings. . . ."

Early Eagles (I and II) drove a single airscrew, but the Eagle 22 was arranged for contraprops in view of its application to the Westland Wyvern T.F.1 deck-landing strike fighter. In M. S. gear the Eagle delivered 3,415 h.p. at 3,500 r.p.m. for take-off. The maximum power rating in M. S. gear was 3,500 h.p. at 3,250ft, and in F. S. gear, 3,020 h.p. at 15,250ft.

THE WELLAND

Active interest in jet propulsion was first shown by Rolls-Royce during 1938, when a department was established for the design of gas turbines. In 1939 the first projects were put in hand, and by 1940 test rigs for components had been set up. Towards the end of that year the company was making components for Whittle units on behalf of Power Jets, Ltd., and was undertaking the manufacture of turbine blades, casings, pumps and other components. During 1941 a special test plant was installed, with a Vulture to drive the compressors, and at the end of that year, under instructions from the Ministry of Aircraft Production, the company undertook the development and manufacture of Whittle-type turbojets, in conjunction with Power Jets, Ltd., and the Rover company.

The first Rolls-Royce turbojet, known as the WR1, measured 54in in diameter and was designed for a thrust of 2,000 lb. Built primarily to demonstrate that the aircraft gas turbine could be made completely reliable, it ran for some 35 hr. Two examples were built, but combustion trouble was experienced.

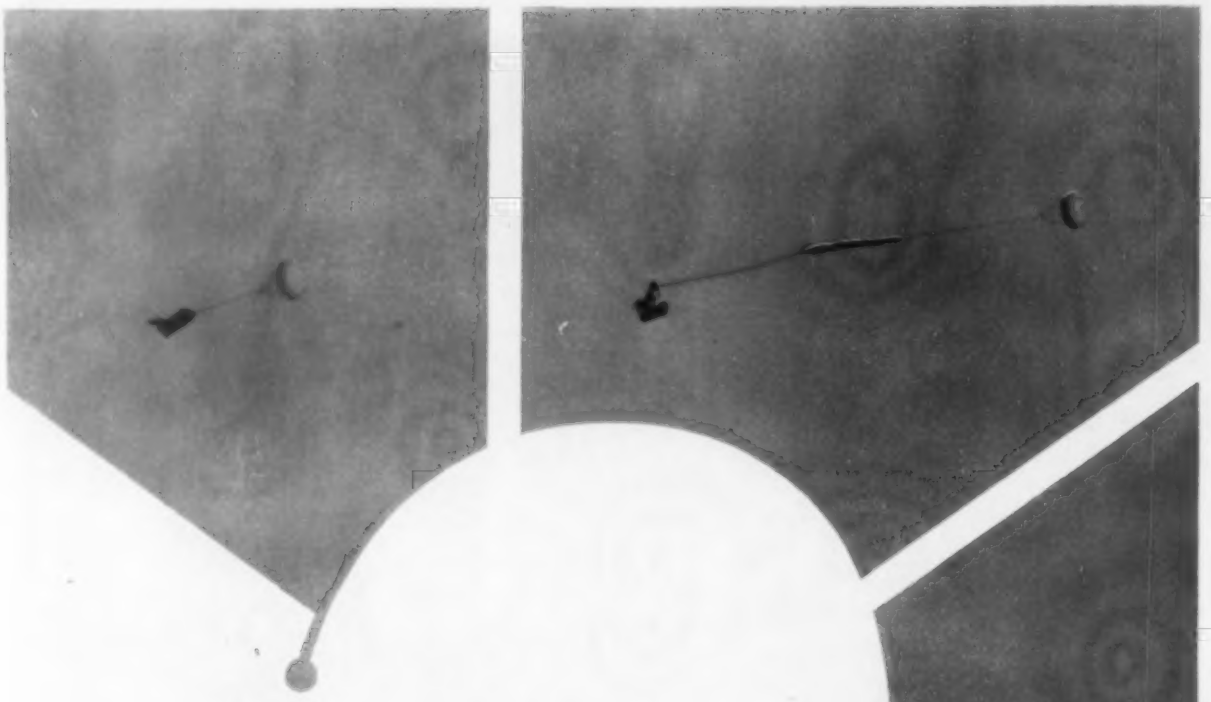
Early in 1943 Rolls-Royce took over research on the W2B/23 unit from the Rover company, whose engineers had developed straight-through combustion; units of the type were installed in the Gloster E.28/39 experimental aircraft, and in the tails of two Vickers-Armstrongs Wellingtons. The first Rolls-Royce/Whittle

Powered by an Armstrong Siddeley "Double Mamba"

THE Royal Navy, which has to maintain sea communications, regards counter-measures to the submarine threat as of first importance. Much of the new anti-submarine equipment is specialised, and demands unique capabilities and characteristics from the aircraft employed. To cover this feature of defence the Fairey Gannet is in super-priority production, and has also been ordered for the Royal Australian Navy.

FAIREY AVIATION

THE FAIREY AVIATION COMPANY LIMITED · HAYES · MIDDLESEX



On the 17th March, 1954, an ejection in straight level flight was made from a Meteor 7 aircraft with the Martin-Baker Patent fully Automatic Ejection Seat.

The speed 600 m.p.h., the height only 150 feet.

One second after ejection, drogue developed and holding seat steady and slowing it down.

Three seconds after ejection, parachute fully developed with 80 feet in hand.

Patent in the principal countries of the world and certain patents pending

MARTIN-BAKER

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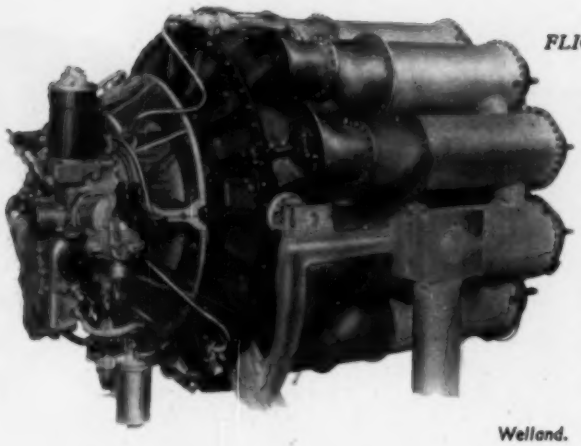
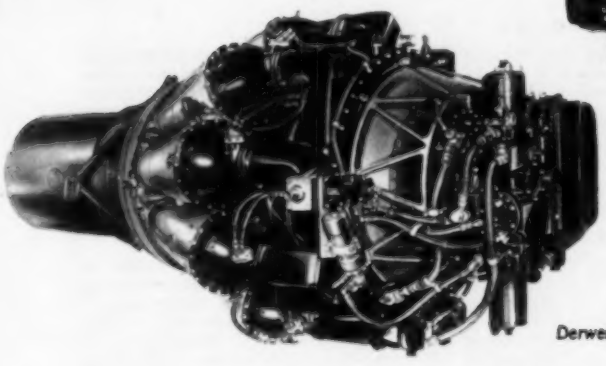


Welland.

W2B/23 passed its 100-hr type-test in April 1943, and was given the name Welland; in June 1943 two were fitted in the Gloster F.9/40 (prototype of the Meteor), and by May 1944 Wellands were being regularly delivered for R.A.F. Meteors.

The Welland had a reverse-flow combustion system, a maximum diameter of 43in and could develop 1,700 lb, although for the F.9/40 it was at first derated to 1,450 lb.



Derwent 8.

THE DERWENT

While work on the Welland was in hand Rolls-Royce were already proceeding with a new design to utilize experience gained from their development work. The project was to be of the same maximum diameter, in order that it might be installed in standard Meteor nacelles, but it was to develop 2,000 lb thrust. Drawings were started in April 1943 and by July the new unit was ready for test. In November of that year it passed its 100-hr type-test at the full 2,000 lb rating and in April the following year it went through its first flight tests in a Meteor, with a Service rating of 1,800 lb and a weight of 920 lb. It was known by its experimental designation B.37 or, in conformity with the "River" nomenclature, as the Derwent I. The Derwent II gave a thrust of 2,200 lb, and the III was a special unit to provide suction for boundary-layer removal; the Derwent IV was rated at 2,400 lb thrust. The Derwent 5 was an entirely new engine—still of 43in diameter, but developing twice the thrust of the original Derwent I. It was, in effect, a scaled-down version of the Nene, and its development was motivated by the promise shown by the Nene and the knowledge that the Meteor could utilize thrust greatly in excess of the original estimates.

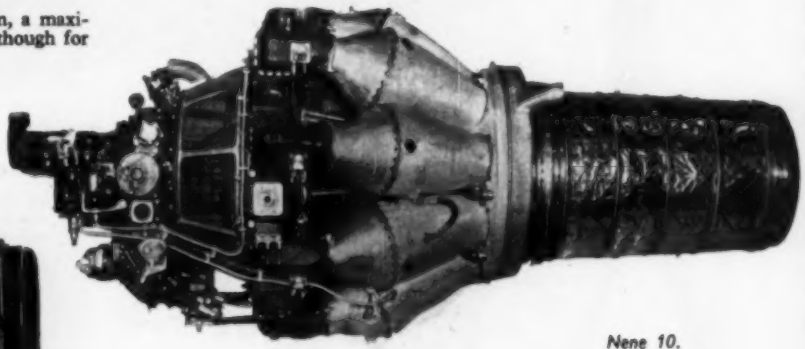
The Derwent 5 was superseded by the Derwent 8 and 9. The 8 incorporated two outlets to feed compressor-air through piping to heater muffs on the exhaust unit; tappings were taken from these muffs to heat the cabin and the guns and/or camera. The 9 used the same method of heating, but had in addition larger combustion chamber-inter-connectors and high-energy ignition to give more consistent relighting in flight as well as to increase the altitude at which relighting was possible.

The body of a typical Derwent is built up on the compressor rear casing which, though immensely strong, is very light and is considered by Rolls-Royce to be a fine example of their foundry technique. On the front face are the diffuser ring, the front casing and front air intake, and the wheelcase. To the rear the main structure comprises the rear air intake, the cooling-air casing and the centre and rear bearing-housings, which successively lead to the nozzle-box assembly. This last takes the gas flow from the combustion chambers and distributes it to the annulus of stationary nozzle-guide vanes; it also carries the auxiliary cooling-air ducts leading from the region of the turbine disc and rear-bearing housing.

Centrally runs the main rotating assembly, and disposed round the engine, between the compressor casing outlet elbows and the nozzle-box, are the nine combustion chambers. So carefully balanced is the rotating assembly that as much as a minute-and-a-half elapses before it comes to rest after the engine is shut down. At maximum static thrust the characteristic double-sided impeller deals with 62 lb of air per second, with an efficiency of 80 per cent and a compression ratio of 4 : 1. For this task it needs about 8,000 h.p., which is transmitted from the turbine through the coupling. The impeller is 24in in diameter and has 29 vanes on each side. Guide vanes convert axial to radial flow.

Maximum thrust of the Derwent 8 is 3,600 lb at 14,700 r.p.m., and the specific fuel consumption is 1.01 lb/hr/lb.

Experimental Derwents included the RD.9, which had a 15 per cent increase in mass flow, and the RD.10—a scaled-up version utilizing the rotating parts of the Nene. The RD.11 was another scaled-up development.



Nene 10.

THE NENE

Designed to a Ministry of Aircraft Production specification of 1944, calling for a turbojet having a maximum diameter of 55in, a minimum static thrust of 4,000 lb and a weight not exceeding 2,200 lb, the Nene, as has already been explained, is the "big brother" of the later Derwents. Consideration was given in the early project stage to the scaling-up of a Derwent to meet the specification, but as this would have entailed increasing the diameter to nearly 60in a new design was put in hand and was completed in 5½ months. In this the diameter was kept down to 49½in and a thrust of 5,000 lb was attained.

The design of the nine combustion chambers follows Derwent practice. Each consists of a cast expansion chamber attached to an outer air-casing containing a flame tube. About 15 per cent of the air entering each chamber is directed by perforated baffles and swirl-vanes in the flame tube into the combustion zone around the burner head. In this zone, where the air is turbulent and moving slowly, the primary air flow, together with a small reverse flow round the flame tube, mixes with the fuel sprayed from the burners and burns at a flame temperature of 1,600-2,000 deg C. To prevent distortion of the flame tube due to local overheating caused by flames impinging on the walls, a thin layer of air is admitted round the inside periphery of the tube through a circular "window piece." The remaining air flows between the flame tube and air casing, and communicates with the combustion zone through rows of holes in the flame tube. This diluting air is consequently expanded and accelerated rearwards, but it also cools the products of combustion to the temperature required at the turbine inlet.

Current marks of Nene include the 3, with electric starter motor and two torch-igniter units (this powers the Supermarine Attacker F.1); the Mk 10, which is similar to the Mk 102 later mentioned but has a larger wheelcase of accessories (this is the engine of the Canadair Silver Star); the Mk 101, specially adapted for the Sea Hawk and having a horizontal gear-box drive, Plessey turbo-starter and divided jet-pipe; and the 102, which is interchangeable with the III but has various design changes, including two high-energy igniters. This last powers the Supermarine Attacker F.B.2. Nenes have also been installed in the Gloster E.1/44, an experimental Lockheed Shooting Star and the Dassault Ouragan.

THE TWO Rs . . .

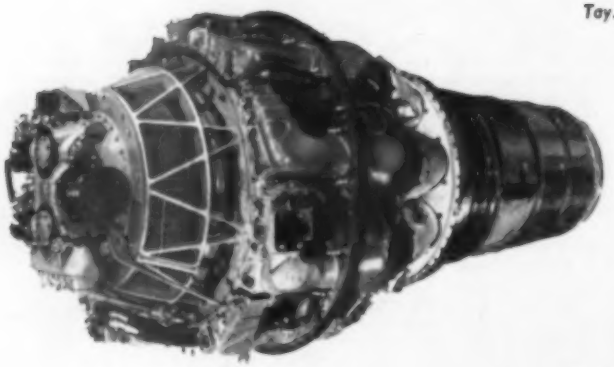
THE TAY

Little known in England (though two units of the type were test-flown in a special Vickers Viscount), the Tay was developed in the first instance by Rolls-Royce from the basic Nene design. It has been further improved by the Pratt and Whitney and Hispano-Suiza concerns, which, respectively, hold the American and French licences. In America the engine is known as the J48, and its applications include the Lockheed F-94C Starfire, Grumman F9F-5 Panther and F9F-6 Cougar. Ratings of 6,250-7,000 lb have been recorded without water injection, a power-boost system which increases thrust by about 1,000 lb.

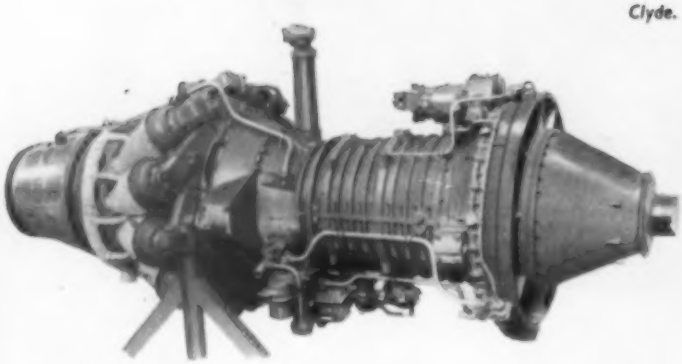
Hispano-Suiza Tays have been installed in Dassault Mystère II, III and IV fighters, and the production Tay 250 is for the Mystère IVA. A development of the Tay by the French company is called the Verdon (following the "River" nomenclature) and has a modified compressor with new guide-vanes, revised flame-tubes and combustion chambers, and new turbine-blades and disc. A special afterburner has been developed for this engine, which is to replace the Tay in the Mystère IVA. (Afterburning experiments with both the Derwent and Nene were made some years ago by the Rolls-Royce company.)

Trent.

Tay.



Clyde.



Avon RA. 14.

THE TRENT

This was Britain's first turboprop, and the first turboprop in the world to fly. It was on test as early as March 1945, and in September of the same year two units were installed in a Meteor. Experimental work with the Trent (RB.50) actually dated back to May 1944, when a Welland was equipped with a spur-type reduction gear and tested for shaft horsepower. The Trent was built solely to gain experience with a unit combining jet and airscrew propulsion, and was merely an early Derwent with reduction gearing and a small-diameter, five-bladed airscrew.

THE CLYDE

The RB.39 Clyde was a large turboprop designed before the end of the late war. It was remarkable in having a nine-stage axial compressor and a single-stage centrifugal compressor, in addition to two turbines. The forward (high-pressure) turbine drove the centrifugal blower, and the rear (low-pressure) turbine the axial compressor and contra-rotating airscrews. The Clyde was the first turboprop to pass its full civil and military type-tests. Its first tests were run at 2,500 s.h.p. and this was later increased to 3,020 s.h.p. Subsequent ratings were 3,500 e.h.p., 4,200 s.h.p. and 4,500 e.h.p.; these last proved that the reduction gear was capable of standing greatly increased overloads. The Clyde was flown only in the Westland Wyvern strike fighter.

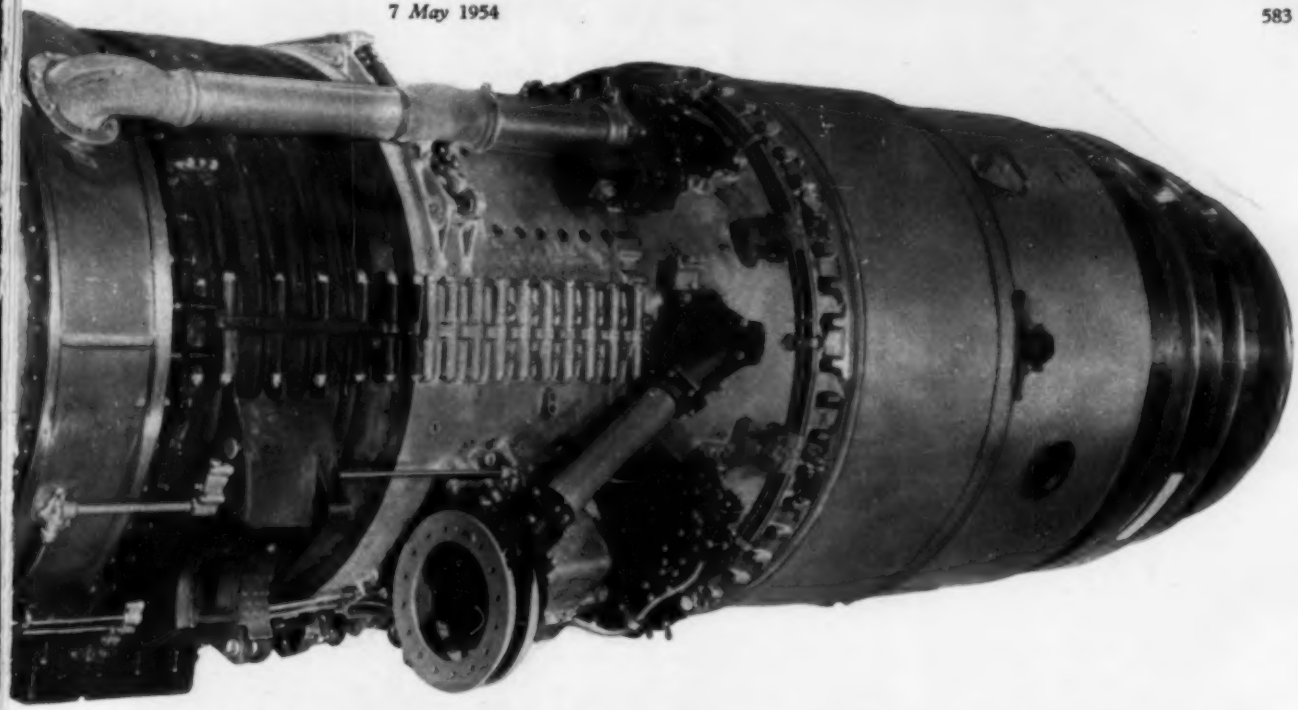
THE AVON

The Avon is, in effect, the modern Merlin and, like the Merlin, it had its early troubles; but it is now firmly established as one of the most reliable aero engines of all time.

Originally designated AJ65 (signifying an axial unit of 6,500 lb thrust), it went into production during 1950 for the English Electric Canberra bomber. For the historical record, the prototype RA.2 weighed 2,400 lb and gave 6,000 lb thrust, while the production RA.3 was 125 lb lighter. The second basic type to be built in series was the RA.7, which, in 1952, became the progenitor of a 7,500-lb thrust family of Avons. The first of the series with all-weather protection, the RA.7 had a power/weight ratio even better than that of the original production engines, notwithstanding the fact that it had been restressed to accept the loads imposed at transonic speeds. The RA.7R (the suffix "R" denotes that reheat, or afterburning, is fitted) delivers 9,500 lb static thrust at sea level, and an offshoot of the same family is the civil 500 Series, the 503 being the engine of the Comet 2.

The latest series of Avons is headed by the RA.14, which first ran in 1952. These newest Avons are considerably redesigned and, although no detailed description is permissible, it can be seen that the RA.14 has a longer compressor than its forerunners, and that it also has a true annular combustion chamber—the latter, no doubt, in order to accept the tremendous mass flow without increasing "hoop" diameter.

The R.A.14 appears to be intended for installation in the wing (it is known that it powers the Vickers-Armstrongs Valiant B.1), and every effort has been made to reduce depth to a minimum.



A civil counterpart is the RA.16 of 9,000 lb thrust, which was originally intended to power the Comet 3, though that aircraft is now intended to have a much later variant, giving 10,000 lb thrust.

Development flying was undertaken in an adapted Lancaster and a Meteor, and Avons are now flying in the D.H.110, Hawker Hunter, Supermarine Swift, Supermarine 508/529, Saab Lansen, Dassault Mystère IVB, English Electric Canberra, Short S.A.4, Vickers-Armstrongs Valiant, and de Havilland Comet 2.

THE DART

This compact turboprop is quite unique, not only in respect of its technical make-up, which we shall describe, but in being at the time of writing the only turboprop in regular service in the world. Although it has achieved renown as the power unit of the Vickers Viscount, it has also been flown on a limited scale in the Avro Athena and Boulton Paul Balliol advanced trainers.

The Dart is characterized by a two-stage centrifugal compressor, handling about 20 lb of air per second, and a two-stage turbine. Steel guide vanes direct the air between the 19 rotor blades, from which it is impelled at high speed. After passing through a diffuser the flow is directed through curved passages, formed by the compressor casings and inter-stage guide vanes, into the second rotor.

The two stages of the turbine are locked together on a common shaft and the blades of the high and low pressure stages have "fir tree" roots. Both discs are cooled on their front and rear faces, and a steel-strip seal prevents gas leakage between the stages. There are seven combustion chambers.

Under tropical conditions lost take-off power is restored by water/methanol injection.

Now coming into production for Viscounts is the Dart RDa.6, which has a new reduction gear and other refinements, making possible a maximum rating of 1,500 h.p. Another new engine is the RDa.5—almost completely new, and designed for even greater powers. It is scheduled to power the Viscount 800 Series.

The following data apply to the Dart 505: diameter, 37.9in; length, 95.1in; dry weight, 1,030 lb; max. power, 1,400 s.h.p. plus 365 lb thrust; equivalent shaft horsepower, 1,515 at 14,500 r.p.m.; specific fuel consumption, 0.83 lb/hr/e.s.h.p.

THE CONWAY

Though it may be said that this is an engine of the "by-pass" type, no illustrations or technical details may be published. In a by-pass engine the excess air from an oversize low-pressure axial compressor is passed around the combustion chambers, so that a far greater mass flow results, and at a lower mean velocity, than in a simple turbojet burning fuel at the same rate.

UNNAMED TURBOPROP

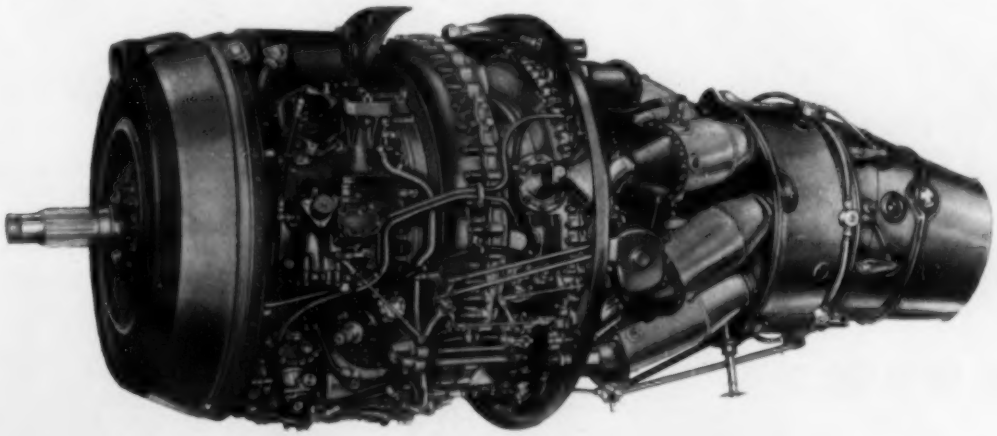
Another new and semi-secret Rolls-Royce development is an extremely compact turboprop intended for civil use. Under development as a private venture, it will initially have a rating of about 2,500 s.h.p., but far greater powers should be forthcoming.

PRODUCTION

Between 1915 and 1924 Rolls-Royce aero-engine production was: Eagle, 4,674; Hawk, 200; Falcon, 2,185; Condor, 327.

The total production of Kestrel *engines was 4,750, of* Buzzards *100, and of "R" engines 20.*

More than 150,000 Merlins *were built in Great Britain and the U.S.A. by the end of the war, and* Griffon *production to date is over 6,000.*



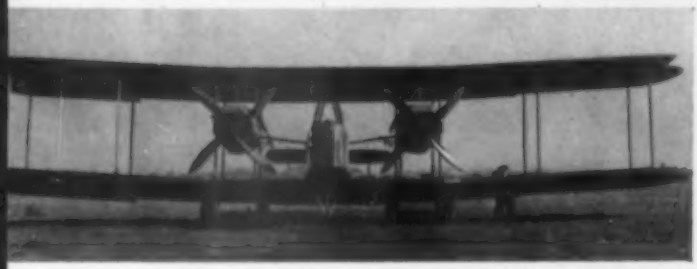
Dart.

THE TWO Rs...

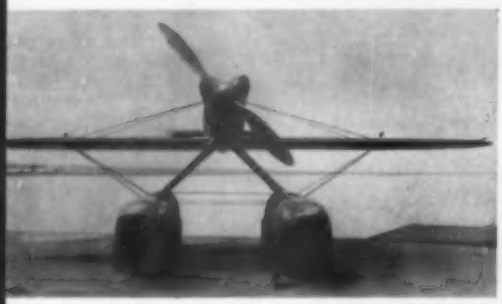
FRONTAL AREA

Without exception the Rolls-Royce aero engines have been notable for their small head resistance and their amenability to clean installation, though both these considerations—as this unique collection of head-on views emphasizes—are of a relative nature. Comparing, for instance, the views of the Vimy of 1918 and the Valiant of today, one sees in the former two massive power-eggs housing a total of 750 h.p., while in the latter the presence of the equivalent of, perhaps, 70,000 h.p. is proclaimed only by the air intakes and slight bulges in the wing surfaces. Likewise edifying are the views of the Supermarine S.6B racer and the Spitfire fighter. Not shown are modern single-jet fighters such as the Hawker Hunter and Supermarine Swift, wherein the Avon turbojet is completely submerged in the fuselage.

Bristol Fighter F.2B (Falcon III).



Vickers Vimy (two Eagle VIII).



Supermarine S.6B ("R" engine).

Hawker Hart (Kestrel IB).

Handley Page Heyford (two Kestrel IIIS).

Supermarine Spitfire prototype (Merlin C).

Avro Lancaster prototype (four Merlin X).

Fairey Firefly I (Griffon XII).

de Havilland Hornet F.1 (Merlins 130/131).

English Electric Canberra B.1 (two Avon).

Vickers-Armstrongs Valiant B.1 (four Avon RA.14).

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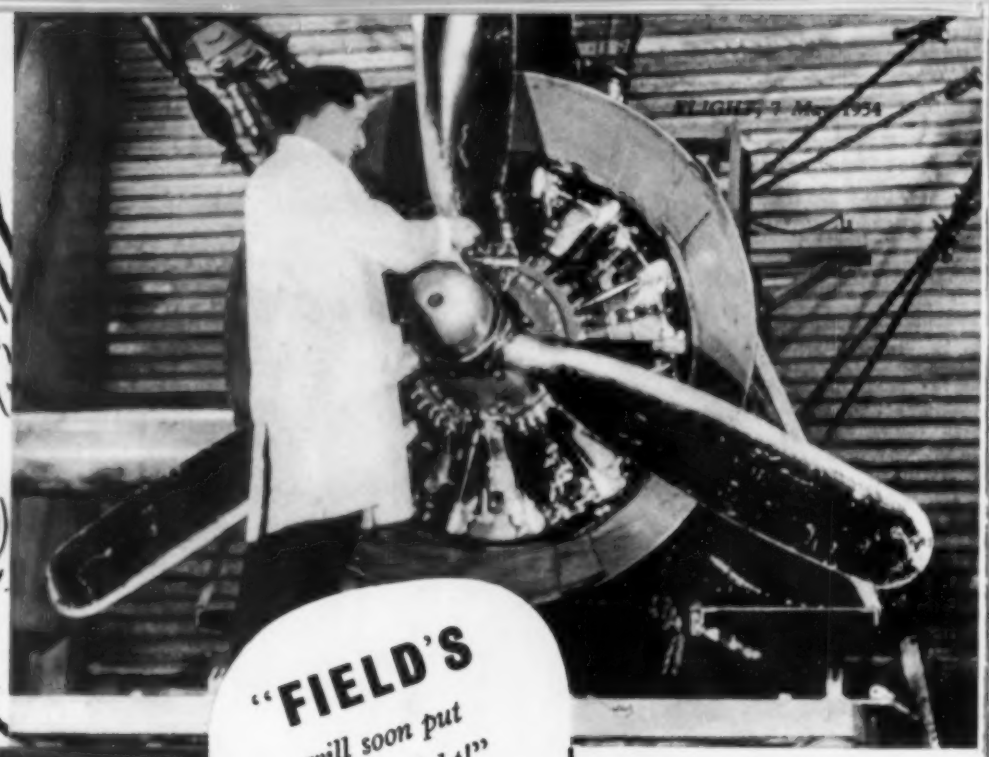

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TWO SUPERS: The pleasing upper picture shows one of the French C.A.B. Supercabs now undergoing fully-instrumented test flying at Villacoublay; Jacques Noetinger is the pilot. The lower photograph shows a production North American F-100A Super Sabre booming out of Los Angeles Airport; as the angle of the slab tailplane shows, the aircraft is not climbing at the angle that the attitude suggests.

AIRCRAFT INTELLIGENCE

U.S.A.

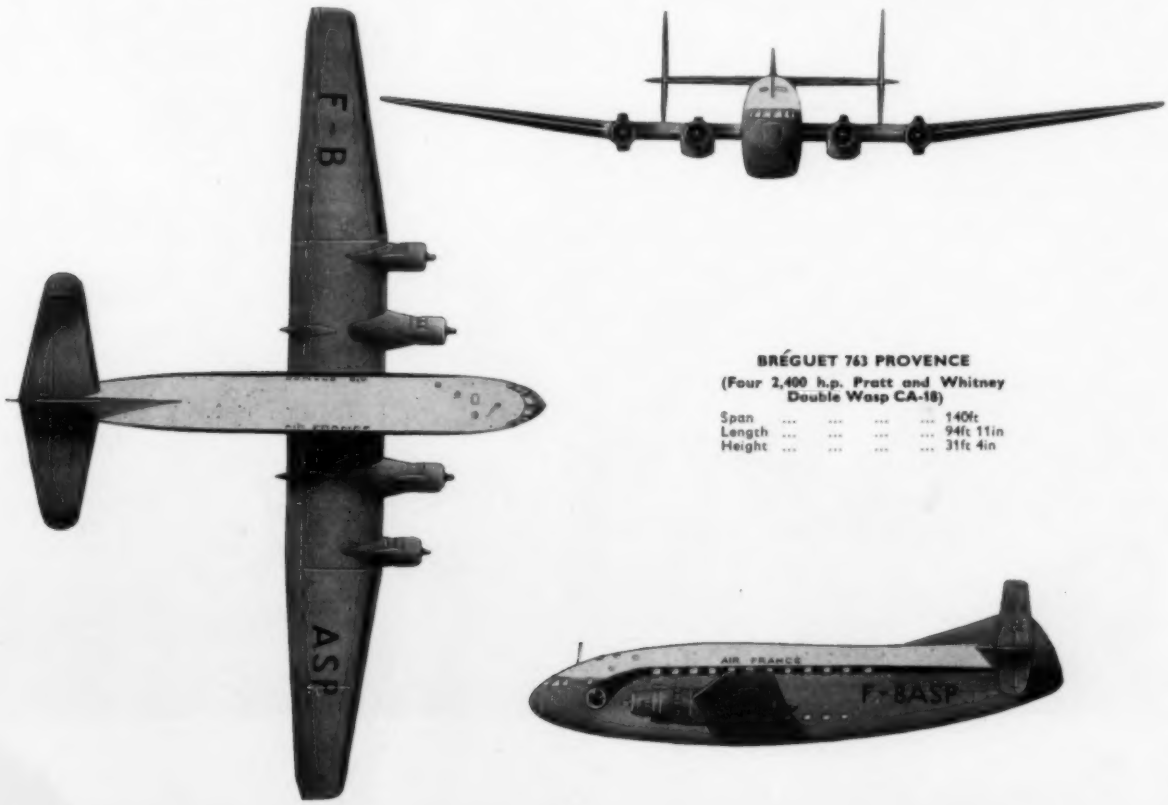
Douglas Skyray. The new Douglas factory at Torrance (Plant B-6) is now in volume production with both the AD-5 and 6 Skyraider and the F4D-1 Skyray, the latter with the J57 turbojet with afterburner. This leaves the El Segundo division almost clear to turn out twin-jet Skywarriors; the U.S.A.F. version of this machine (B-66) is made at Long Beach, and the main factory, at Santa Monica, makes Globemasters and DC-7s. Present Navy contracts for the Skyray are sufficient to keep Torrance busy until the end of 1956. Now comes a report to the effect that a new variant, the F4D-2, is being developed "with some configuration changes." After manufacture at Torrance, Skyrays are put aboard a flat truck and taken to El Segundo, where final operational equipment is installed preparatory to flight testing.

North American F-100. The U.S.A.F. have now accepted delivery of a fair number of F-100As (an early production machine is shown above), but some have already been damaged or written-off in accidents. The height of the rudder has recently been reduced by some 18in and a corresponding amount added to the fin. The whole F-100 structure is immensely strong and rigid; so much so that assembly jigs are rendered unnecessary, the parts being simply put together. The wing interior is largely taken up by huge forgings, machined into honeycombs or grids; some of the outer skins are machined from sheet of no less than 3in original thickness. There is much talk of the aircraft being made by Commonwealth (Australia) and Canadair.

France

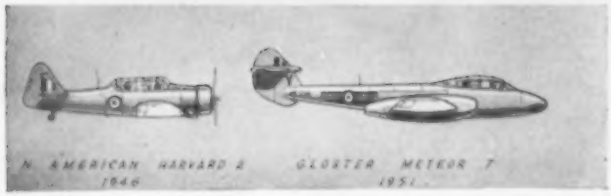
Bréguet Provence. Subject of this week's drawing, the big Provence is a true double-decker, hence its maker's apellation *Deux Ponts*. Described from the passenger's point of view in our issue of April 10th, 1953, the Provence can carry as many as 107 passengers. Air France have 12; they are used mainly on routes to North Africa, but some have worked extra peak-period services to London Airport.

Dassault Mystère. Having almost completed all Ouragan contracts for the Armée de l'Air, for the Indian Air Force (where 71 are in service under the name *Toofani*), and against off-shore orders, Dassault are beginning to turn out Tay- and Atar-powered Mystère 2s. These will be followed by the RA.7R-powered Mystère 4B and the impressive 4N. The first prototype 4N is being assembled; it looks much like a Sabre F-86D with two tandem seats and has a single-piece "all-flying" tailplane and full radar interception fire-control.



BRÉGUET 763 PROVENCE
(Four 2,400 h.p. Pratt and Whitney Double Wasp CA-18)

Span	140ft
Length	94ft 11in
Height	31ft 4in

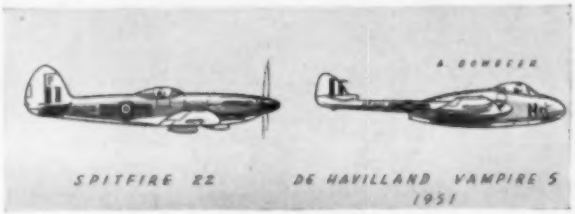


Training (left) and operational types during the more recent life of No. 603.

THE QUEEN'S SQUADRON

A History of No. 603 (City of Edinburgh) Squadron, Royal Auxiliary Air Force

By JOHN YOXALL *Part III*



THIS is the final instalment of our history of No. 603. The first part, published on April 23rd, told of the squadron's pre-war existence and of its part in the battles of Britain and Malta; the second instalment, last week, was mainly devoted to the long series of Mediterranean operations in which 603's pilots repeatedly distinguished themselves; and the present article carries the story through the period of the enemy's retreat in Western Europe and brings it up to the present day.

AN operation typical of the period took place on January 17th, 1945, when the Spitfires of 603, together with those of 602, acted as fighter and anti-flak escort to 36 Beaufighters attacking shipping off Den Helder. At 1330 hr 12 Spitfires, with W/C. Burke leading, took off to rendezvous with 602 Squadron and the Beaufighters. At 1335 hr all set course. The Spits climbed to 12,000ft and crossed the Dutch coast four or five miles south of Den Helder, making a wide orbit to the target. They dive-bombed and shot up the flak positions for about two minutes before the Beaufighters came in. Strikes were seen along the whole length of a 5,000-ton flak ship and a destroyer was hit and blew up. It was impossible for the Spitfires to see the results of the Beaufighter attack, but from congratulatory messages received later it appears that the whole show was successful. All the Spitfires got home safely, but six of the Beaufighters were lost; one pilot was heard over the R/T. to say that he was in flames and another to say that he was about to make a forced landing in a field.

A curious incident occurred two days later, when W/O. Cookson's aircraft returned from an armed reconnaissance with a hole in the tailplane; the cause was attributed to either a falling cartridge case from another aircraft, or to a bomb-vane.

A frequent target for "Ramrod" attacks was Loosduinen tramsheds, which as an operation came to be called "Yo Yo" because it was always either on or off and bombs were either "up" or "down." At one period Loosduinen was laid on every day for three weeks running without being achieved. On one of the off days the pilots watched American combat films of German jet aircraft.

Owing to the continued ill-health of S/L. Patterson, command of the unit was taken over by S/L. T. C. Rigler, D.F.M., who was one of "The Few." He had been "B" Flight commander.

One of his first tasks was to call a conference to discuss the merging of the old 603 Squadron people with the present unit. The administrative fusion of the two squadrons was organized. A talk was given to all pilots on the history and record of the City of Edinburgh squadron (the speaker was F/L. Oddy, who had been the adjutant in North Africa) and the identification letters on the fuselages were changed over to the old 603 marking.

S/L. T. C. "Tommy" Rigler, D.F.C., D.F.M., the C.O. during the anti-V2 campaign.

The squadron was having a very busy time, occasionally doing as many as three shows a day. On February 14th, for instance, 37 sorties were flown, totalling 43 flying hours. Many of the Spits were carrying air-burst bombs.

On "off" days—the result of English weather—there were the usual football games to be played, or operational ciné films to be shown. On one afternoon there were talks by F/L. Kirkman and F/Sgt. Webb, who related their experiences while escaping from captivity—Kirkman from an Italian prison camp near Ravenna, and Webb while waiting for the Allies to overrun the area in which he landed after being shot down.

On February 24th a move was made from Coltishall to Ludham, nearby—a move which was not very popular, for the squadron had just made itself comfortable. The attacks against targets on the Dutch coastal regions continued. Operational flying hours for the month totalled 380, and 447 bombs were dropped. There were no casualties.

March of 1945 certainly "came in like a lion" and on the 1st the squadron were endeavouring to dive-bomb V.2 sites in winds of over 50 m.p.h. The dives were made from 10,000ft down to 2,000ft, on an east-west course, but aiming was not very good—most of the bombs fell short. The high winds persisted through the next day but the shooting improved, six direct hits and an equal number of very near misses being scored.

The squadron was working extremely hard. Each day, when

Memorable scenes at Drem after eight Spitfires of No. 603 Squadron had escorted German Naval and Luftwaffe chiefs in from Norway to arrange the handing-over of German forces. The Germans flew in white-painted Junkers Ju 52 aircraft, one of which is seen on the right.

the weather was at all possible for flying, hourly from 0830 to 1630 a section of Spitfire 16s took off to attack V.2 launching and storage sites in Holland. There was no opposition from the air; and flak varied from "light inaccurate" to "heavy accurate." The targets were difficult to find and to hit; only occasionally were the pilots able to report—as they did on March 4th after attacking a site at Rust en Vreugd—a large yellow flash and smoke rising to 800ft. That the pilots were not doing all the work, however, was recognized by a party, given by the C.O. in a local hostelry, to the senior ground-crew N.C.O.s as a token of appreciation of their very hard work.

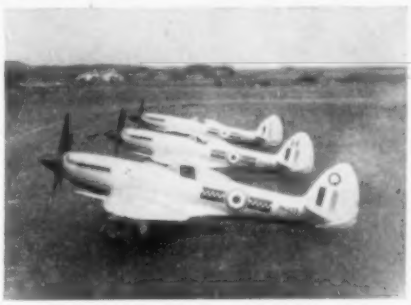
March 10th was a day of which No. 603 was proud. They were the only squadron in the wing to maintain incessant attacks throughout the day despite ten-tenths cloud (in those days there were no "eight-eights") at 5,000ft. In all, over 20,000 lb of bombs were dropped during 41 sorties totalling 55 flying hours, Two aircraft were hit by flak, but W/O. Haupt put down at Knocke Le Zoute and W/O. Mee was able to make base. Continental bases were now used not only by those having to force-land but also for operational purposes. Often during March sections would leave Ludham, bomb a target, land to refuel and re-arm at Ursel, make another attack, and return to Ludham.

The squadron's all-time high came on March 20th, when a wing effort was put on in honour of the sector commander,

The Queen, as Princess Elizabeth, inspecting her squadron on the occasion of the presentation of the Esher Trophy in August, 1951. She is accompanied by S/L. Anson, the Commanding officer at that time.

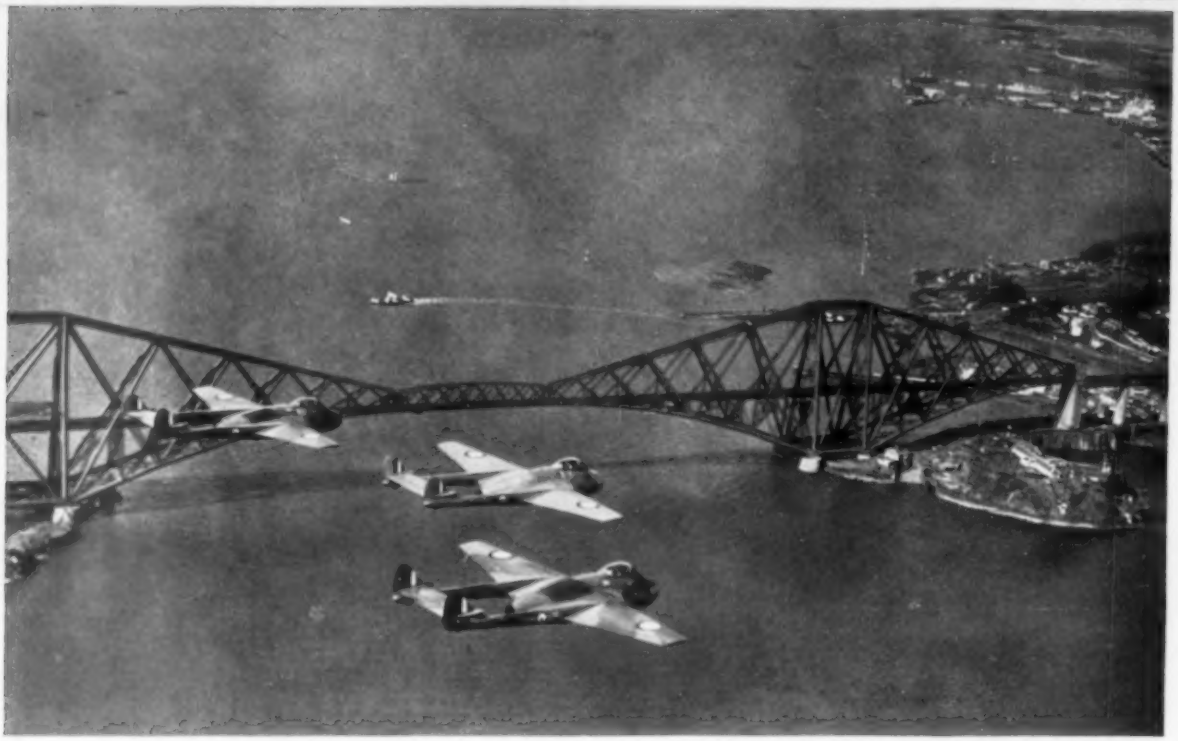
"Flight" photograph

Three old hands: Sgt. F. Day, with 19 years' service in the squadron; F/S. D. McKenzie, B.E.M., with 20 years; and F/S. C. E. Erskine, B.E.M., with 26 years.



(Right) Back to squadron markings: Post-war Spitfire 22s wearing No. 603's insignia.

Present members and aircraft of the squadron. In front, left to right, are: F/O. Ballingall, F/O. McIntosh, F/L. G. W. Scott, F/O. Ewan, P/O. Milne, F/O. Taylor, Sgt. Knowles, F/O. Henshaw, Sgt. Inglis, S/L. Schofield, F/L. Moncur, F/L. Cairns, F/L. McIntosh, F/L. Anderson and F/L. Marsh.
"Flight" photograph



Familiar territory for No. 603: Three of the squadron's Vampire 5s flying past the Forth Bridge—a "Flight" photograph by the author of this history.

THE QUEEN'S SQUADRON . . .

G/C. Donaldson, D.S.O., D.F.C., A.F.C., who was relinquishing his command. The wing flew 165 sorties, 57 of them by No. 603 in 72 flying hours; 14 aircraft were employed and 56,000 lb of bombs dropped.

At the end of the month came the news of the award of the D.F.C. to the C.O., S/L. T. C. Rigler, D.F.M., just as he learned of his posting from the unit to a training post at Catfoss. No. 603 were sorry to lose such a fine commander. He had eight enemy aircraft to his credit, had been wounded twice and had risen from sergeant pilot to squadron leader. He was succeeded by S/L. H. R. P. Pertwee, D.F.C., who came from the rival squadron, No. 602 (City of Glasgow).

March was also the last effective month of the war so far as No. 603 was concerned, for the rapid advance of the land forces cut off the V.2 launching sites in Holland from their supply bases. As a result the squadron was transferred from dive-bombing

S/L. R. A. Schofield, the present Commanding Officer, conducts an informal briefing of his pilots for a recent exercise.

"Flight" photographs

High-level portraiture: S/L. R. A. Schofield removes his oxygen mask for a moment, to appear more photogenic while flying the squadron's Meteor 7.

operations under No. 12 Group to long range escorts under No. 11 Group; but, as the squadron diary records, "the Army once more interfered with our pleasure, the amazing speed of their advance depriving Bomber Command of targets." In actual fact, a number of escorts were carried out.

By the end of April the unit was back at its old home of Turnhouse, events having turned the complete circle. There was little operational flying; the high spot of May—apart, of course, from V.E. Day—was the celebration of the return to the parent city, where the Press turned up in force. A formation of 12 Spitfires was flown over Edinburgh. On May 7th a move was made to Drem.

For May 8th the squadron diary is again quoted: "Today is V.E. Day and Scotland greeted this cheerful announcement with its usual weather. Through the mist and rain signs of celebration could be perceived!"

Three days later it fell to No. 603 to provide an escort to the three white Luftwaffe Ju 52s which brought German naval, army and air force officials from Norway. F/L. Batchelor and F/L. Sergeant led the eight Spitfires.

The effects of demobilization began to be felt almost immediately but monthly flying hours still exceeded the 350 mark. Then an unpopular move was made to Skeabrae in the Orkneys. Though the place proved more pleasant than was expected, an order to move back to Turnhouse on July 29th was welcomed.

But now there were rumours of disbandment; they were finally confirmed on August 9th, and on the ensuing days the pilots had to stand by and watch A.T.A. pilots take away their beloved Spitfires. Japan surrendered on August 14th, 1945, and on the first day of peace No. 603 (City of Edinburgh) Squadron ceased to exist. A farewell party was held.

In the summer of the following year—1946—the Auxiliary Air Force was re-established (the "Royal" prefix was not granted until December 16th, 1947) and No. 603 came to life again under the command of G/C. G. K. ("Sheep") Gilroy, D.S.O., D.F.C., Croix de Guerre, a pre-war member of the squadron. As in pre-war days, each A.A.F. unit was now responsible for its own flying training. The operational flight had nine Spitfire 16s and the training flight four Spit 16s and two Harvard IIBs. F/L. J. A. Sowrey came from No. 164 Squadron for duty as adjutant. At first recruitment was very poor.

Reading the squadron diary now, it is apparent that the attempt to re-form in 1946 was premature. Almost a year passed before

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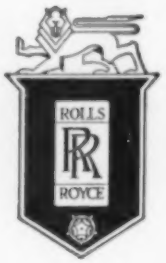

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THE QUEEN'S SQUADRON . . .

any serious flying was done, but in May 1947 No. 603 were able to put up a formation of six Spits when inspected by their Honorary Air Commodore, Sir William Y. Darling.

The first summer camp was spent at Woodvale, the road party comprising 22 N.C.O.s and 26 airmen and the air party 10 officers. In June 1948 the squadron staged an "At Home," attended by some 8,000 citizens of Edinburgh. A visitor was Air Marshal Sir Hugh Walmsley, then Deputy C.A.S., who was once assistant adjutant of the squadron.

In September 1949, S/L. Gilroy resigned and command was taken over by S/L. Holmes. Soon afterwards—on October 6th—there was a hint of things to come: the pilots heard a lecture on the principles of the gas turbine. The squadron had its first jet experience when two representatives of No. 74 Squadron brought up two Meteors, a Mk 4 and a Mk 7. On the latter some of 603's pilots were taken up on demonstration interceptions. May 1950 saw the monthly flying hours exceed 200 for the first time since the end of the war—but this was still on Spitfires and Harvards.

"Flight" photograph

This air-to-air photograph, taken from the squadron's training Meteor 7, shows three de Havilland Vampire 5s in formation over a typical Scottish landscape. Paint schemes vary somewhat.

A change of command came in December 1950, when S/L. Anson took over and S/L. Holmes went to No. 12 Group H.Q. While Holmes had the squadron it had won the coveted Esher Trophy, the prize was duly collected from No. 604 Squadron at North Weald and flown up to Turnhouse in the back seat of a Harvard.

On the last day of May 1951, S/L. Anson made the first flight in one of the squadron's new Vampire 5s, but he had to do so at Leuchars because the Turnhouse runways were still in the process of being lengthened to take jet aircraft. Meteor 7s were available for jet conversion flying; one pilot on his first solo, P/O. Anderson, lost his life when a haar—the northern sea-fog—suddenly closed in on the base. On July 7th, 1951, the last Spitfire flight was made.

In common with other Auxiliary units, No. 603 was called up for three months' continuous training in the summer of 1951 and for this purpose the whole squadron moved over to Leuchars, because their own runways were still under repair. There must have been considerable satisfaction on this occasion, for while at Leuchars, the squadron were presented with the Esher Trophy by Princess Elizabeth (as the Queen was then) the squadron's Honorary Air Commodore.

Exercise Pinnacle formed the culmination of the training period, providing an excellent test in which the squadron acquitted itself well. Embodiment ended on October 14th; the Auxiliaries returned to their homes, No. 603 going back to Turnhouse. The weather became bad and restricted flying a good deal, but after the three months' intensive flying there was a lot of overhaul work to be done; it was, however, hindered by lack of spares and by the need to incorporate modifications.

January weather was little better than that of the previous month and flying was again very restricted. On the 20th six Vampires, led by S/L. Anson, took part in a bomber exercise. As the Very light signalling the "scramble" disappeared into the cloud-base it is not surprising that the Vampires were diverted to Leuchars. Six Washingtons were intercepted at 17,000ft.

In March F/L. J. Storrar left to take over command of No. 610 (County of Chester) Squadron at Hooton Park. His going was regretted. Flying hours were by now exceeding the target; indeed, they had to be conserved for the summer camp, which was to be held at Celle in Germany. The last item of interest before leaving for Germany was the flying of an "E" in honour of the Queen's visit to Holyrood Palace. Timing apparently was perfect, the Vampires passing over Prince's Street just as Her Majesty stepped from her car.

The formation flight of ten Vampires to Celle was to have been led by the C.O., S/L. Anson, but while he was briefing the pilots on the evening previous to the flight, a blackboard fell on his foot and broke three toes. He went by Hastings. Weather at Celle was good; a lot of flying was done and some successful parties were held.

By the end of the year the full training programme had been completed with the exception of air firing, which was continually held up by bad weather. In March, S/L. Anson left to take over the post of O.C. Flying at Church Fenton. S/L. R. Lloyd Davies, D.F.C., who had previously been training officer of No. 600 (City of London) Squadron, took over command.

For summer camp the squadron again went to Germany in 1953, this time to Sylt, and the whole fortnight was devoted to air-to-air firing. Four ranges were in operation, with a Tempest towing a target over each range for periods of an hour at a time. A total of 15,940 rounds was fired for only ten stoppages. Sylt is a holiday resort and everyone enjoyed the camp, but it was marred by a tragedy: S/L. Lloyd Davies, driving a Land Rover, was involved in a collision with a Volkswagen and lost his life. F/L. M. E. Hobson assumed command until S/L. R. A. Schofield was appointed to the post. He came from No. 257 Squadron and is still in command.

W/C. Duncan-Smith, the wing leader at Turnhouse, is an old member of the squadron, and contact is preserved with many of the very early pilots. "Sheep" Gilroy is still a nearby neighbour, and drinks at a recent guest night were provided by him in celebration of the "lambing season"—a daughter.

As the Queen's squadron, No. 603 has an extremely high standard to live up to, but throughout their history they have displayed a spirit capable of rising to great heights. No task given to the squadron has ever been poorly or meanly performed; whatever the occasion, one feels that they are incapable of acquitting themselves other than well.

COMMANDING OFFICERS SINCE JANUARY, 1943

S/L. Patterson, D.F.C. ...	10-1-45	S/L. J. W. E. Holmes, D.F.C., A.F.C.	23-9-49
S/L. T. C. Rigler, D.F.C., D.F.M.	26-1-45	S/L. P. J. Anson, D.F.C. ...	1-12-50
S/L. H. R. P. Portwee, D.F.C.	1-4-45	S/L. R. Lloyd Davies, D.F.C.	22-3-53
S/L. G. K. Gilroy,* D.S.O., D.F.C.	11-6-46	S/L. R. A. Schofield... ...	25-8-53

*War-time group captain.

FILMING THE DAM BUSTERS

SOME further details have been released of the making of the film *The Dam Busters*, on which Associated British Picture Corporation are now at work, using a script prepared by R. C. Sherriff from Paul Brickhill's book.

As already reported, the sequences showing the training for the operation are being made at Windermere by R.A.F. crews in re-commissioned Lancasters. Other scenes, many of which have already been shot, are at Skegness, but the major part of the location work is in the Scampton area in Lincolnshire; it was from Scampton that the squadron took off to bomb the dams, and it is an interesting point that the station commander there at the time of the raid was G/C. John Whitworth, who is advising Associated British during the making of the film.

Other scenes have been made at the N.P.L., Teddington, in the ship tank of which Dr. B. N. Wallis carried out much of his initial work in evolving a mine that would breach dams defended by torpedo-nets.

PIPER APACHE

New American Light Twin in Full Production

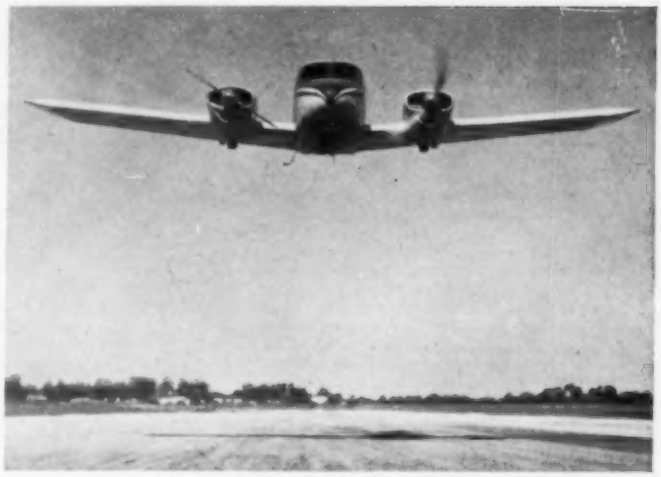
THE field of light twin-engined executive aircraft (which in this country has seen nothing new since the Miles Gemini and Aries) was last year entered by the Piper Aircraft Corporation of Lock Haven, Pennsylvania. Following the company's well-known single-engined high-wing series of Cubs, Super Cubs, Pacer and Tri-Pacer, the new machine (illustrated on this page) is the Apache, now in full-scale production.

Powered by two Lycoming 0-320 engines, each of 150 h.p., the Apache is intended for use by business companies for executive transport (a total of 10,000 aircraft are at present operated on such work by over 8,000 firms in the U.S.A.), and by private owners and taxi operators. Comprehensive instruments and radio equipment have been included to remove the limitation of "daylight, V.F.R. only" flying, and the selling price of the new machine is $32,500, or approximately £11,600.

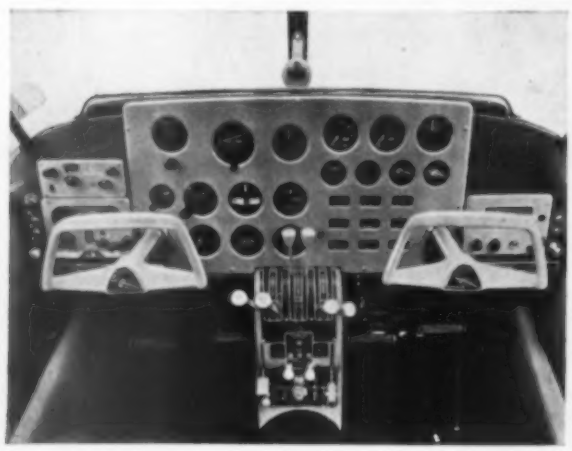
Maximum all-up weight of the Apache is 3,500 lb which, with full tanks, four passengers, full instrumentation and radio, enables 198 lb of baggage or extra equipment to be carried. Maximum sea-level cruising speed is 160 m.p.h. Single-engined ceiling at top weight is 5,000ft, and at 3,100 lb is 8,000ft. A particular advantage is the machine's ability to operate into and out of small fields.

The aircraft is of all-metal construction, and has an empty weight (completely equipped) of 2,170 lb. The "Custom" model is fitted with the three radio installations shown in the cockpit photograph; an autopilot can, in addition, be fitted. The baggage compartment behind the cabin has a volume of 25 cu ft, and the rear passenger seats can be easily removed to increase the available cargo space to 80 cu ft.

The dual controls are conventional, with toe brakes on the left rudder pedals, and with connections to the steerable nosewheel. Rudder and elevator trim controls are located centrally in the cabin roof. The "Electrol" tricycle landing gear is hydraulically retractable and is fitted with Goodrich wheels, tyres and brakes. Two 36-gallon rubber fuel tanks are installed in the wing, outboard of the engines. The span of the Apache is 37ft; length 27ft 1in; and wing area 204 sq ft.



(Top) Apache approach—showing one of the Hartzell constant-speed airscrews in the feathered position. (Centre) The new Piper over Florida. (Below) Pilot's panel and controls; radio equipment comprises Lear radio compass and Narco "Omnigator" (port) and Narco "Simplexer" (starboard). The "Omnigator" is an eight-channel V.H.F. unit providing V.O.R., V.A.R., marker beacon and I.L.S. localizer facilities, in addition to V.H.F. communications; the "Simplexer" is the main 12-channel V.H.F. communications set. (Bottom right) A ground view of the Apache, showing the "Electrol" tricycle undercarriage.



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photographs by courtesy of Rolls-Royce Ltd.

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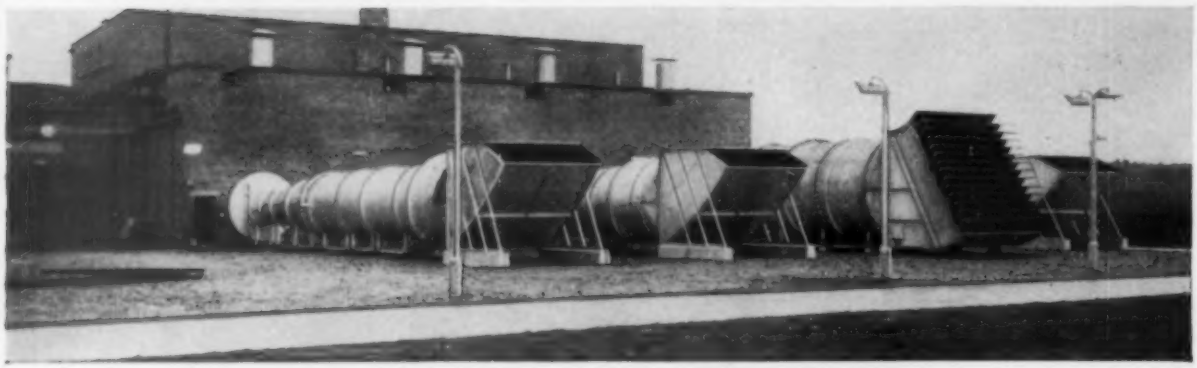

Four of the eight Cullum Detuners installed at this new Rolls-Royce Glasgow Factory.

Air Intakes to Test Beds, showing Acoustic Splitters—designed and installed by Horace W. Cullum & Co. Ltd.

Inside the Test House—Acousti-Celotex Tiles are used for lining the Control Room ceilings.

Examples of the variety of problems solved by the Cullum organisation.

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D 18

FLIGHT of the FIREBEE

THE striking pictures on this page show various stages in the life cycle of the Ryan Firebee remote-controlled target drone. The Firebee weighs 1,800 lb, is 18ft long, 6ft high, and has a span of 12ft. The power plant is a Fairchild J44 turbojet of approximately 1,000 lb thrust; it is 6ft long and 22in in diameter, and weighs 300 lb. Some Firebees have also been flown in the power of a J69 Marboré, built under Turboméca licence by Continental.

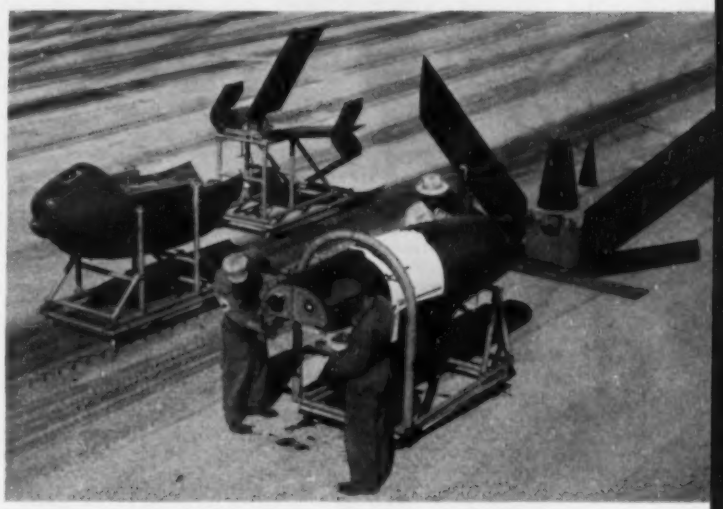
The U.S. Navy, U.S.A.F. and U.S. Army Ordnance Corps have all ordered the Firebee as a pilotless target for anti-aircraft gunnery and missile practice. The U.S.A.F. designation is Q-2; U.S.N. KDA-1; and Army Ordnance XM 21. As described in *Flight* of April 23rd, the Firebee is being developed at Holloman Air Development Center, New Mexico.

There are three methods of launching the Firebee. Air dropping from a B-26 was described in the news-item referred to above; launching from the ground is accomplished with the assistance of a 10,000 lb-thrust two-seconds' duration RATO unit fitted under the rear fuselage, either from a 60ft ramp or from a four-point "zero-length" mounting. In either case, the Firebee is retained on the trolley or on the mounting by shear rivets. Pre-take-off functional checks are made through an "umbilical cord" which, in the case of zero-length launching, is detached by force as the vehicle leaves the mounting.

Recovery, which is normally controlled from the ground by the operator, but which is automatic in case of malfunction or damage, is achieved by means of two parachutes. One 5ft drag-chute is first released to slow the Firebee down, and after a few seconds the main 70ft canopy is deployed. Both parachutes are stowed in the tail-cone.

No details of the Firebee's performance have been released, but it is claimed to have a cruising speed "approaching the speed of sound." While in flight, the Firebee is tracked from the ground by radar.

Ryan are also engaged on other types of missile work, as well as in the development of guidance systems for U.S.A.F. and airborne navigational equipment for the U.S. Navy. The company is responsible, too, for the production of the complete rocket-motor used in an unspecified Army Ordnance surface-to-surface vehicle. This motor was designed by the jet propulsion laboratory of the California Institute of Technology.



This series of photographs shows, reading downwards and then to the left: (1) A Holloman test-crew assembling a Firebee; the various major components are readily recognisable. (2) Final adjustments before setting-up for launching; the fearsome facial decoration distinguishes the Test Center's Firebees from those tested under Ryan supervision. (3) In a billowing cloud of RATO smoke and ground dust, the target roars into the air from a 60ft rail launch; "zero-length" launchers, which can be mounted on a truck, are now being perfected. (4) Back to earth: the Firebee floats gently to the desert surface under its 70ft main parachute.

CORRESPONDENCE

The Editor of "Flight" does not hold himself responsible for the views expressed by correspondents in these columns; the names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

High-altitude Turbulence

WE are extremely interested in the report on high-altitude turbulence given in your issue of April 16th. The information given fully justifies your term "A valuable by-product of Canberra testing" and Mr. Hyde has certainly added a useful amount of background information to this interesting and significant phenomenon.

It appears that the general character of the turbulence, the height ranges where it is most frequently encountered and its horizontal and vertical extents are, as one might expect, much the same as we found in our investigations in 1948-9. [See "An Investigation of High Altitude Clear Air Turbulence over Europe using Mosquito Aircraft," by Hislop and Davies. R. and M. 2737.]

One of the most significant differences, however, is that Mr. Hyde's observations show that severe and violent turbulence occurs relatively much more frequently than we determined from our data. Fig. 5 in R. and M. 2737 would suggest that 50ft/sec. E.A.S. gusts would occur only about one thousandth as often as say a moderate gust of 20ft/sec. As far as one can determine from Mr. Hyde's observations, the corresponding ratio for the Canberra flights is one-thirtieth.

Considering the simply vast extent of the atmosphere and the relatively small samples of the atmosphere which have been taken in both series of observations, it is possible that the samples are biased in opposite directions, though part of the difference may be attributed to the fact that Mr. Hyde's observations were made in a more localized area where the incidence of turbulence is perhaps greater.

Sustained areas of turbulence warranting the definition of "violent" cannot be neglected in high-altitude passenger-carrying operations. Even where turbulence is not in itself violent our results suggest that the frequency of encounter of these "cobble-stones" might well coincide with the natural frequency of vibration of an aircraft wing of a large aircraft, and hence the structural implications of this have to be very carefully examined.

With the increasing accent on high-altitude, high-speed passenger transport we believe that the existence of high-altitude clear-air turbulence should not be too lightly dismissed, but that instead an intensive investigation should be made, particularly as to the likely extent, severity, and best means of its avoidance over the North Atlantic.

Hayes, Middlesex. G. S. HISLOP, D. M. DAVIES.

Convertible Helicopters

IT is evident from Mr. Hafner's Blériot Lecture, reported in your issue of March 12th, that his preliminary studies on aircraft for vertical take-off and landing have not yet revealed to him that such aircraft became a practical proposition in 1942, when fighter aircraft had about 1 h.p. for every 4 lb of weight. This is made clear in my unpublished papers and submissions to the Ministries and others from 1942 to date.

The reason is that aircraft with power/weight ratios of the order of 1 h.p./4 lb can be fitted with propellers which give adequate thrust for vertical landing and take-off, and also give high efficiency at high speed. Aircraft with 1 h.p./4 lb have speeds of 400 m.p.h. and above.

At lower speeds and power/weight ratios, rotors of the helicopter type have to be used, and these are too large to be efficient in forward flight, and cannot be made strong enough without incurring unacceptable weight penalties. The large rotors mounted on the wings, and the low top speed due to the power-required curve being similar to that of helicopters, means that Mr. Hafner's "convertible" combines the worst features of two-rotored helicopters and aircraft, namely the rotors and the overlarge wing.

As aircraft speeds increase above 400 m.p.h., so do power/weight ratios, and the faster the aircraft the easier vertical take-off and landing becomes. Such aircraft can have much less aerofoil area than orthodox aircraft of similar power, and therefore have better performance. Mr. Hafner's curves show his "convertible" to have a lower performance than orthodox aircraft.

The logical course of development is to adapt aircraft for vertical take-off and landing, rather than attempt to convert helicopters which have too much drag and too little power to go fast anyway. There is no point in building a "convertible" to fly say five years hence more slowly and uneconomically than orthodox aircraft do at present, particularly when it is easier to make aircraft for vertical take-off and landing which can outclass orthodox aircraft in every respect.

Also, helicopter rotors imply helicopter operating conditions, and landings and take-offs would be impractical in high winds. The turbulence caused by Mr. Hafner's gantry building would make landings additionally hazardous. The answer to this problem is to land aircraft a short distance away on transporters running on rails, and bring them to the building after stopping the engines.

Another of the snags with Mr. Hafner's layout is that, on failure of one rotor, his "convertible" would be unbalanced sufficiently to cause a crash. The best way of avoiding unbalance is to use counter-rotating airscrews at or near the nose. In any case the wings of aircraft for vertical take-off and landing, designed for speeds above 400 m.p.h., are too small to mount rotors on.

The foregoing should not be construed as opposition to aircraft for vertical take-off and landing. On the contrary, having worked overtime on them since 1942, I am the strongest believer in the country, knowing that safety, economy and performance dictate their universal use.

It is important, however, that time and money should not be diverted to dead-end development now that the official telescope is belatedly transferred from the blind eye.

East Grinstead, Sussex. J. R. ANDERSON.

Airfield "Victorianism"

HAVING just received your issue of March 5th, I was interested to read your Editorial, "Airfield Network," and feel it deserves the widest possible circulation amongst local authorities, town planners, M.P.s, etc., who might have some say in the future of the many abandoned airfields in Great Britain. At the moment, many seem to be following the example of their early-Victorian forebears with regard to the railway, and trying to keep these "new-fangled ideas" as far away from their spheres of influence as possible.

In one case with which I am familiar, the local authorities are seeking to destroy an ideally placed airfield, close to a large town in a developing area, and are trying to reopen various rights of way across it. Whilst being well aware that vast concrete runways, etc., are probably unnecessary, and of the need to return as much land as possible to agricultural production, surely some area of the present aerodrome could be retained for flying purposes. The paradoxical attitude seems to be to try to retain the amenities of a locality whilst ignoring perhaps the greatest amenity of the present and future.

Finally, I would like to express my appreciation of your periodical. Living in a place where one seldom hears, let alone sees, an aircraft from one week's end to another, it is pleasant to be kept in touch through such an excellent medium.

Tanganyika Territory. D. J. B. NICHOLLS.

Reminiscing

I WONDER how many readers of *Flight* who were fortunate enough to have experienced the joy of flying the various aircraft from the Sopwith Stable in World War I ever came across the few two-seater Sopwith Camels which were produced. At the squadron to which I was attached at the time they were nicknamed "Skewer," due to the fact that the instructor, who sat in the front seat, had the end of the hollow crankshaft of the rotary engine (complete with Bloctube carburetter) a matter of inches away from his chest; and in the event of a crash he was generally "skewered" on the end of the crankshaft.

The Sopwith Dolphin (which, I believe, followed the Camel) we nicknamed "Blockbuster." This was because the pilot's head protruded through a gap in the top plane, and the aircraft had a tendency when landing on rough ground to turn upside down, with the result that the pilot took the full weight on his head, with disastrous results. A modification consisting of a canopy made from steel tubes placed over the aperture in the top plane, with the object of taking the weight of the aircraft if it turned over, greatly reduced the number of "blocks busted."

The Sopwith Snipe, with its B.R. rotary engine was another winner out of the same stable. The B.R. engine was, I believe, one of the first rotary engines to have aluminium cylinders and in the early days gave a lot of trouble due to piston seizures.

The most famous Snipe I came across belonged to Major Billy Bishop, V.C., the Canadian pilot who was attached to No. 24 Squadron at Croydon for a short period round about 1918. The whole of the aircraft was painted pure white and both sides of the rudder were adorned with a life-size picture in colour of a Red Indian in full war paint and feathers.

Whilst at Croydon with 24 Squadron—which, incidentally,

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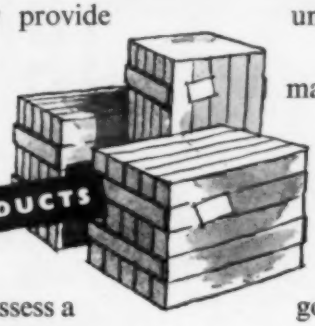

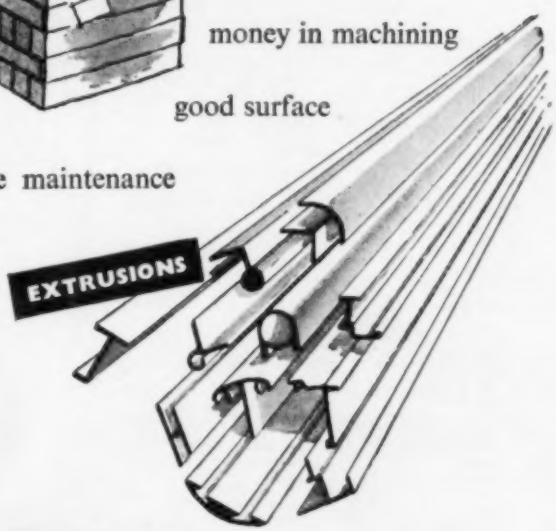

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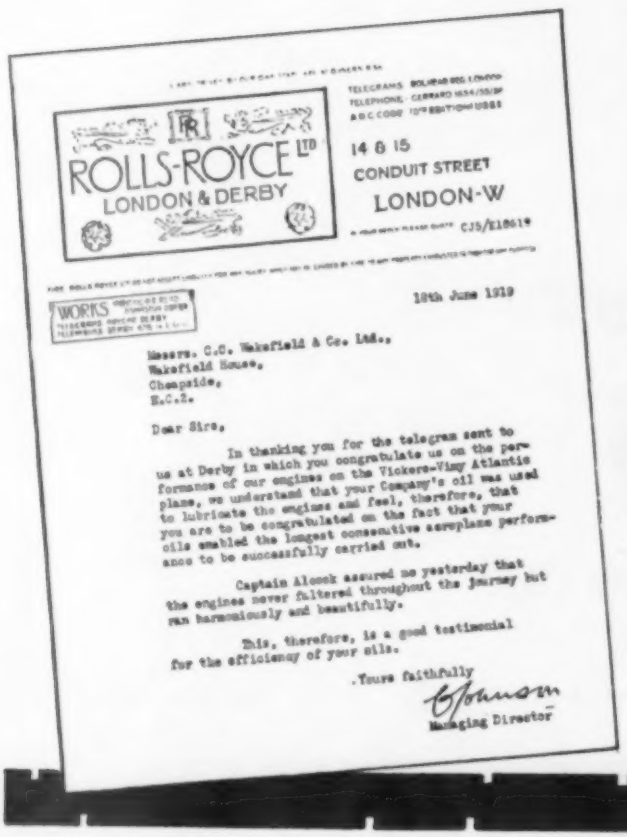

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18th June 1919

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Dear Sirs,

In thanking you for the telegram sent to us at Derby in which you congratulate us on the performance of our engines on the Vickers-Vimy Atlantic plane, we understand that your Company's oil was used to lubricate the engines and feel, therefore, that you are to be congratulated on the fact that your oils enabled the longest consecutive aeroplane performance to be successfully carried out.

Captain Alcock assured me yesterday that the engines never faltered throughout the journey but ran harmoniously and beautifully.

This, therefore, is a good testimonial for the efficiency of your oils.

Yours faithfully

Managing Director

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This advertisement was published in 1919 by C. C. Wakefield & Co. Ltd.

CORRESPONDENCE . . .

became the Air Council Inspection Squadron—we had what I believe was one of the first air ambulances. I cannot remember who made the aircraft, but it was called the Salamander. The stretcher was carried in the fuselage behind the pilot and the patient was protected all round by heavy armour plating. Being the smallest and lightest member of the squadron, I was persuaded on a demonstration flight for the Air Council to be a "patient"; and I am quite sure that if the patient was only half dead when placed in the aircraft he would be completely so after touch-down, because the experience was really terrifying. I think it was the only one of its type which was made and I never heard of it going into production.

Surely one of the most beautiful planes produced during World War I was the little Vickers Scout, made for the Air Ministry but never taken up officially. Vickers presented it to McCudden, V.C., who used it as his own private aircraft. It was a small biplane with very low ground clearance. The top plane was only approximately 5ft from the ground and McCudden had it painted entirely red.

The only time I saw it was when he visited our squadron, which at that time was stationed on the race-course at Hooton, near Liverpool. I believe it was in this plane that McCudden was killed when he returned to France and crashed at take-off from one of the French aerodromes when he was flying back to his own squadron.

One last memory-tester. Can any readers remember an Avro 504 K being fitted with five seats and having a C. of A. issued for joy-riding purposes?

Derby. J. P. HERRIOT.

Opportunities in Canada

IT is unfortunate that most reports and letters published in the Old Country concerning conditions in Canada emanate from such individuals as "Disappointed" [April 2nd] for whom, incidentally, I would propose "Sour Grapes" as a more appropriate nom-de-plume. Anyone who contemplates uprooting his home and family and moving to a new country owes it to his family, to himself and to his new country, to consider carefully all the relevant factors and not only the obvious and superficial ones.

As an emigrant from England to Canada, in particular to the Province of Quebec (and, I suspect, much closer to the employer of "Disappointed"), and as one who was instrumental in persuading a number of Britons to emigrate to Canada, I feel compelled to comment on the points raised in "Disappointed's" letter.

So far as my employer is concerned, recruiting campaigns which started 5½ years ago have resulted in the employment of 115 persons from Great Britain. It is hoped and expected that, as a result of another campaign about to be launched, a further substantial number of experienced and responsible aircraft engineers will emigrate to Canada. The reason for additional recruitment is not primarily to replace losses but to increase the engineering staff to handle an extensive design-programme.

Of the 115 recruits from Great Britain, eight have left for jobs in the United States, one has returned to England, and 11 have been promoted to supervisory status. Engineering first line supervision (Group Leaders) is composed of 2½ per cent Americans, 23 per cent British Commonwealth other than Canadians, 54 per cent Canadians, 15½ per cent Polish and 5 per cent others. Second-line supervision (section chiefs) is composed of 13½ per cent Americans, 33½ per cent British Commonwealth other than Canadians, and 53 per cent Canadians. "Experience, qualifications and organizing ability" are assessed as such without regard to origin. There is no reason for believing that the advancement of a British immigrant to supervisory status is more rapid in the U.S.A. than it is in Canada.

Junior men are certainly used on modification work, and it is expected that thereby they will become the senior men of the future. At present the proportion of senior to junior men is higher than normal and, due to unanticipated delays in the implementation of a new design-programme, senior men have also been employed on production modification work. Waiting periods are not unknown in the aircraft design business and are to be deplored; it is nevertheless significant that no competent engineers have been discharged, but have been retained on modification work in anticipation of a go-ahead on new design.

The ratio of 9:1 dollars to pounds is the highest that I have seen quoted so far. On the basis of comparative status in the social scale (not to be confused with standard-of-living, which is higher here than in Great Britain for equivalent social status), ratios varying between 5:1 and 7:1 have been quoted by British immigrants in Montreal.

There is one point on which I am pleased to agree with "Disappointed"; the way of life *is* very different. Most immigrants seem to like it—a few do not.

Montreal, P.Q. R. F. O. SMITH.

The Cierva Autogiro referred to in the letter from Mr. Warner, below.

Early Autogiro

REGARDING Mr. Delaney's letter in *Flight* of April 2nd, enclosed is a photograph [reproduced above—Ed.] taken at Farnborough about 1927 which may be of interest. The fuselage of this version of the Cierva Autogiro was an Avro 504 N, with Armstrong Siddeley Lynx engine.

New Milton, Hants. W. W. WARNER.

Historic Seaplane

I WAS very interested to read in your issue of April 2nd a reference, on page 394, to Short No. 42 converted to a landplane. This machine commenced its career in the Naval Wing of the R.F.C. (as it was then known) at the Seaplane Station, Leven, Fifeshire, in July 1913 under Maj. R. Gordon, R.M.L.I., and was converted to a landplane at Dundee in the summer of 1914 and flown from a small strip at the Seaplane Station, Dundee, by Maj. Gordon.

I was one of the small party who left Eastchurch in July 1913 to open the seaplane base at Leven, our complement of machines being Short seaplane No. 42, one Borel monoplane on floats and later one Henri Farman seaplane.

I have a photograph that was taken on the beach at Leven; unfortunately only the tail position is in view but there is no doubt of its being Short No. 42.

After forty years on aircraft of various types both in construction and operation, from my first introduction in January 1913 to B.E.2s in C Flight, Central Flying School, Upavon, by flight commander Capt. John Salmond, to the present day I have many happy memories of the early types and the comradeship of those connected with flying, all giving of their best regardless. So different from the present days of bonus payments and of the job not being the first consideration.

It would be interesting to know how many of the early members of the Naval Wing of the R.F.C. are still around and in the aircraft industry.

Eastcote, Middlesex. G. E. WELBOURN.

FORTHCOMING EVENTS

May 3-14. British Industries Fair, London and Birmingham.
May 9-16. Saar Aero Club: International gliding contest and rally.
May 13. R.Ae.S. Section Lecture: "The Use of Materials in the Plastics Range", by H. L. Cox, M.A., F.R.Ae.S., A.M.I.Mech.E.
May 15-17. Channel Islands Aero Club: International rally, St. Peter's Airport, Jersey.
May 17-28. Gauge and Tool Exhibition, New Horticultural Hall, London.
May 20. R.Ae.S.: 42nd Wilbur Wright Memorial Lecture: "The Choice of Power Plants for Civil Aeroplanes," by Dr. A. E. Russell, B.Sc., F.I.A.S., F.R.Ae.S.
May 21. Institute of Navigation: "Visual Aids to Bad-weather Approach," by Dr. E. S. Calvert.
May 22. Leicestershire Aero Club: Air display.
May 25. Society of Instrument Technology: Annual general meeting.
May 29. R.A.F.A. Cheltenham and Gloucester: Air Display, Staverton.
May 29. Percival Aircraft, Ltd., and Field Aircraft Services, Ltd.: "At Home" to owners of Percival aircraft, Luton.
May 29. Ragosine/Auster Homing Cup Competition, Rearsby, Leicester.
May 29-30. Leghorn Aero Club: Air Tour of Tuscany.
June 2. Pescara Aero Club: International aerobatic contest.
June 5. Swansea and District Flying School and Club: Welsh Air Derby.
June 5-6. Niedersachen Section of Aero Club of Germany: International air rally, Hanover.
June 5-7. French Aero Club: Rally.
June 6. Modena Aero Club: International aerobatic contest, Modena.
June 7. S.S.A.F.A.: Air display, Yeadon Aerodrome.
June 9-19. Mechanical Handling Exhibition and Convention, Olympia.
June 11-13. Royal Netherlands Aero Club: International air rally.
June 11-14. Palermo Aero Club: Sixth International air tour of Sicily.
June 13. R.Ae.S. Garden Party, London Airport.
June 18-19. R.Ae.C.: National Air Races, Coventry Civic Aerodrome.
June 21-24. Institute of the Aeronautical Sciences: Annual summer meeting, Los Angeles.
June 26. Plymouth Air Display Committee: Air display.
June 26-27. Aéro-Club de Flers de l'Orne: Normandie Rally.
June 30. Northamptonshire Aero Club: "At Home."
Sept. 7-12. S.B.A.C. Farnborough display and exhibition.

THE INDUSTRY

Bristol Progress

RESULTS of the Bristol Aeroplane Company's trading for the year ended December 31st, 1953, announced last week, show that net profits were £582,661 (1952, £563,829) after charging taxation at £795,115 (£922,921).

At a board meeting on April 26th, it was decided to recommend a final dividend of 6½ per cent on the £4,620,000 Ordinary stock, equivalent to £165,165 net. With the interim dividend of 3½ per cent already paid, this makes a total of 10 per cent for the year. Gross dividend on the Ordinary and Preference capital, as increased in December 1952 by a bonus issue to Ordinary stockholders, is £525,000.

The 44th annual general meeting is to take place on May 20th, and the statement by the chairman, Sir William G. Verdon Smith, has been issued in advance; it is given elsewhere in this issue.

In the statement, mention is made of new facilities, at the company's Weston-super-Mare factory, for helicopter production. Some further details, announced last week, show that the aviation work formerly carried out by the Bristol Aeroplane Company (Weston), Ltd., has now been brought under the direct control of the aircraft division of the parent company, while production of permanent aluminium buildings will in future be the responsibility of a new section, to be known as the buildings division. Mr. W. Strachan remains in charge of the Weston factory, and Mr. P. W. Lawson has been appointed general manager of the buildings division, with Mr. A. D. Cawse as divisional secretary.

These changes, it is stated, have been made necessary by the growing volume of aircraft work being handled by the Weston departments and by the need to provide additional production capacity for Sycamore and Type 173 helicopters. The Weston factory will now be employed solely upon aviation work.

Lodge Plugs in America

A SALES organization has been formed in America by Lodge Plugs, Ltd. Known as Lodge Spark Plug Co., with registered offices at 1320 Venice Boulevard, Los Angeles, California, it has a Board of directors consisting of V. Martin-Jones (president), managing director of Lodge Plugs, Ltd., England; B. D. Bacon (vice-president), sales manager, Lodge, England; A. J. Ayers (secretary and treasurer); J. Burnett; and E. R. Jackson. Mr. C. P. Pages, until recently the London-office manager, is going to America to take over the organization of the main distributing office.

The new company is marketing all Lodge plugs manufactured in this country that are suitable for use in America.

Flaw-detection "On the Job"

THOUGH the principle of flaw-detection by magnetic methods is now well established, most of the apparatus so far available is of a kind intended for permanent installation in works test-departments. Clearly, if the equipment is of a fully portable nature its operational value is greatly increased, since components can in many instances be tested *in situ*. Such portability is a feature of the Minchom "Sempun" magnetic flaw-detector (R.P.R. Patents, Ltd., Alexandra Palace Station, London, N.10), which is already in use by a number of well-known airframe and engine constructors; there are indications, also, that aircraft operators are now recognizing the adaptability of this equipment.

The general arrangement of the "Sempun" detector is apparent in the accompanying photograph. It consists, basically, of two magnetic pole shoes, two side-links, and a central magnet, the coil-casing of which forms a carrying handle. These five units are linked together by ball joints, so that the pole shoes may be presented to the test-work at any of an infinite number of angles, and over a maximum span of 12in.

A typical application of the "Sempun" flaw detector.

The problem of obtaining full contact between the shoes and the work-face has been solved by providing each shoe with 45 sliding pins which move into contact with the face under the influence of magnetic force, no matter how irregular the surface. Magnetic force exerted over a 2in gap is stated to be variable between 100 and 350 Oersteds.

The magnet is of semi-permanent type, and is designed to be periodically re-magnetized—i.e., after some hundreds of tests—by connecting two leads for a moment to a twelve-volt car battery.

For tests of small components, magnetic force may be reduced by turning the joint-balls in their spherical seatings; each ball contains a non-magnetic lamination which, dependent upon its angle in relation to the lines of force, controls the flow.

Work is prepared for testing by spraying the surface with a quick-drying white medium against which the detecting-ink is clearly visible when it takes up its characteristic demarcation along the line of a flaw. Flaws existing beneath the surface are also revealed, though the clarity of the indication naturally depends upon the depth at which they lie. The detector is stated to operate effectively even on painted surfaces.

The detector measures approximately 7in × 5in × 1¼in, and weighs 6 lb. It is supplied in a Rexine-covered case containing also a check test-piece, remagnetizing leads, and the fluids.

Measuring Vertical Acceleration

THE performance of modern intercepters has underlined the importance of an efficient means of measuring acceleration in the vertical axis. The new air-damped accelerometer illustrated here is the first of a range of simplified aircraft instruments produced by Wynstruments, Ltd., of Staverton Aerodrome, Gloucester.

The instrument consists primarily of a weight in the form of a piston suspended on a coil spring, both being contained in an accurate-bore glass tube sealed at each end by rubber plugs. The piston carries a white line which reads against a scale on the face, which is graduated in units of ½g over a length of 5¼in. Two types of instrument are at present available, reading respectively from zero to 4g and zero to 8g.

Air damping is effected by the small clearance between the outside diameter of the piston and the inside diameter of the glass tube. This damping, which is normally set at 0.7 critical, is claimed to remain virtually constant at all altitudes.

It is stated that flight tests, carried out on a number of prototype aircraft in England, have already resulted in a substantial number of orders being placed; installation drawings are now available.

IN BRIEF

Cellon, Ltd., announce their 1953 net trading profit as being nearly £94,000 (1952, £97,000); group profit, covering the parent and associated companies, was £115,000.

* * *

Industrial solenoids are the subject of a new brochure, including full performance data, issued by Oliver Pell Control, Ltd., Burrage Road, London, S.E.18.

* * *

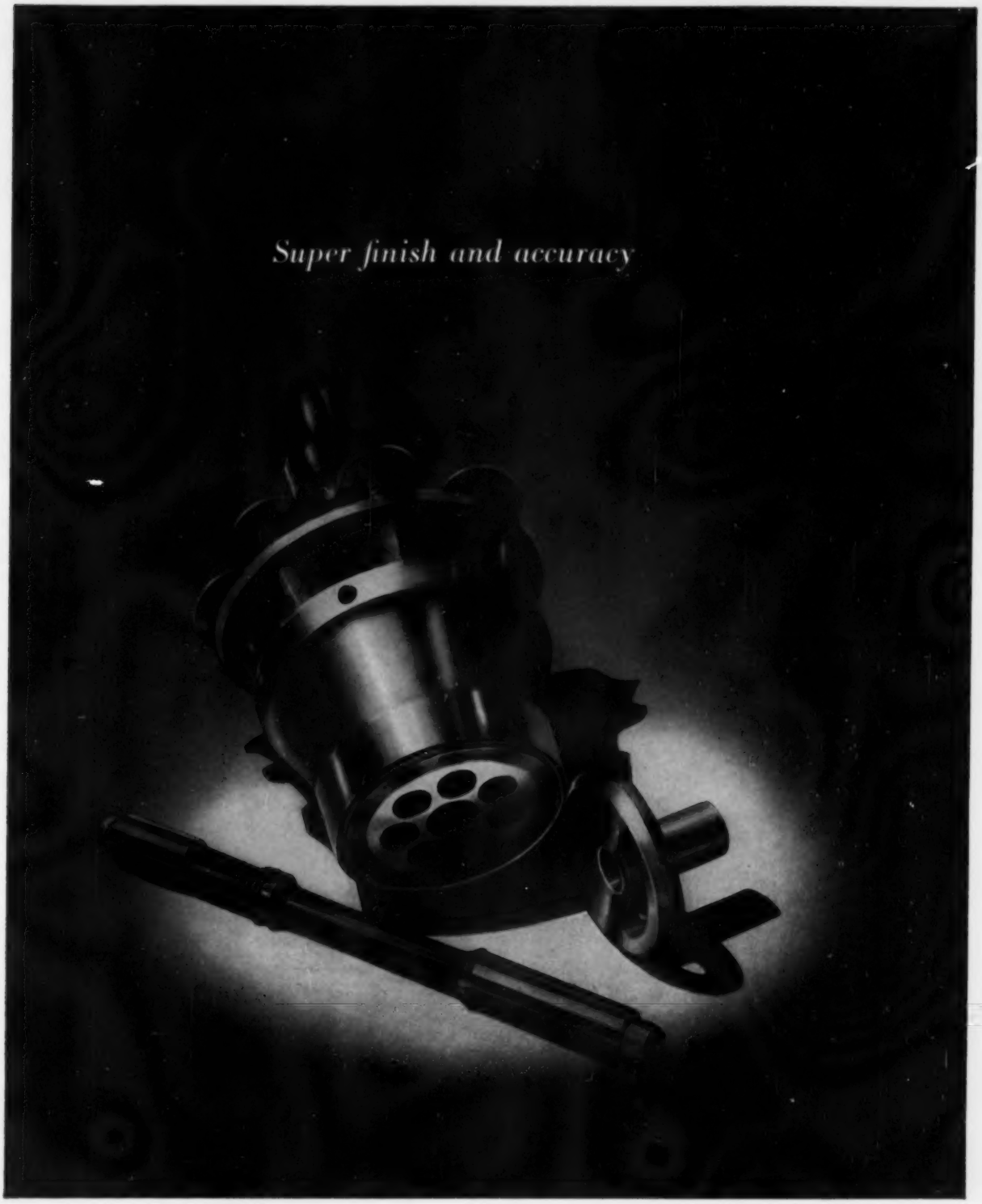
From Murray Lornie Thomas, Cairnleith, Alyth, Perthshire, comes a current stock-list of several thousand aircraft standard parts (B.S.S., A.G.S., S.B.A.C., etc.), together with details of components, instruments, airfield equipment and tools.

* * *

Heenan and Froude, Ltd., of Worcester, have received an order from the Bristol Aeroplane Co., Ltd., for a special high-speed Froude hydraulic dynamometer to be used in gas-turbine research work. Rated to absorb 1,000 b.h.p. at speeds up to 12,000 r.p.m. it is said to be capable of achieving new standards of accuracy and in sensitivity of readings.

* * *

Ardente Acoustic Laboratories, Ltd., announce that, in order to increase production capacity, a licence to manufacture and sell their intercommunication, loud-hailer, marine "talk-back" and marine and general public-address equipment has been granted to Easco Electrical, Ltd., 6-8 Brighton Terrace, London, S.W.9 (Brixton 4961). Easco have already started manufacture of the equipment under the technical direction of Mr. D. B. Eastell, A.M.I.E.E. Mr. F. Dennis Dent, A.M.Inst.B.E., A.M.I.R.E., M.Inst.P.I., Ardente managing director, joins Easco's Board.

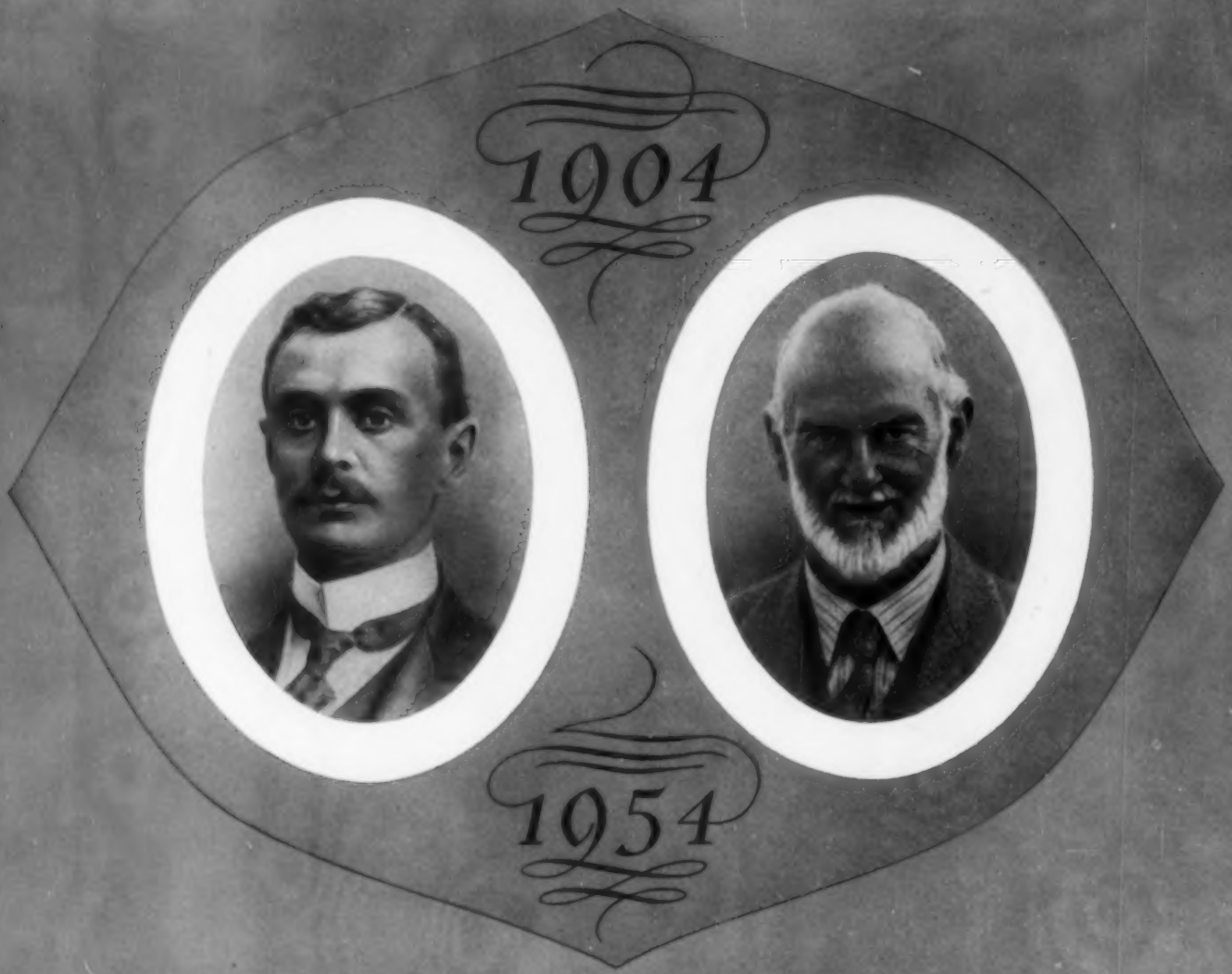


No. 3. Petrol at 2,000 p.s.i. flows from these fuel-pump components—of selected materials and finishes down to 2 micro-inches. Lubricated only by the fuel, these reciprocating and rotating parts operate at speeds up to 4,000 r.p.m.

FUEL AND COMBUSTION SYSTEMS FOR GAS TURBINE ENGINES

LUCAS

JOSEPH LUCAS (GAS TURBINE EQUIPMENT) LTD., BIRMINGHAM & BURNLEY



50 years ago the meeting of the Hon. C. S. Rolls and Frederick Henry Royce led to the formation in 1906 of the Rolls-Royce Company, whose name is now a hallmark of engineering perfection. As world-wide licensees for the famous R.R. series of aluminium alloys we are proud of our association with a company whose products are known and respected throughout the world.

HIGH DUTY ALLOYS LIMITED · SLOUGH · BUCKS

CIVIL AVIATION

TOWER OF LONDON: Dominant feature of the central terminal area at London Airport, the new 122ft-high control tower is approaching completion and will come into use later this year.

THE COMET SITUATION

INEVITABLY, the loss of Comet G-ALYY on April 8th, and the consequent withdrawal of the Certificates of Airworthiness for Comets remaining in airline service, have had far-reaching results. The entire Comet production programme has been "frozen" and the effect on airline planning obviously goes deeper than the present grounding of a small number of Series 1s. The situation as it had developed by the beginning of this week was as follows:

Investigation of the three unexplained accidents holds the key to the future of the Comet. It is obviously not possible at present to quote any estimate of the time which may elapse before a final conclusion is reached—one way or the other. A public inquiry into the accidents will be held, but the time and place have not yet been announced. Meanwhile, intense efforts are being made to find possible causes for the disasters. All remaining British-operated Comets are now in this country, together with an Air France Series 1A.

Comet G-ALYX, which was in Cairo on the day of the accident to G-ALYY, was flown back on April 21st, and G-ALYW completed its journey back from Colombo on April 27th. Both aircraft were brought back under permits-to-fly; they flew in short stages and maintained an average height of 20,000ft as a precautionary measure. De Havilland technicians at Hatfield have been conducting detailed examinations of G-ALYU and G-ALYX, and the R.A.E. at Farnborough have taken possession of another B.O.A.C. Series 1, G-ALYS. Plans for flight trials are said to be well advanced, although no details of the form which they will take have been released. It seems probable that most, if not all, of the test flying will be from Farnborough. Structural tests on G-ALVG, the first prototype, have been under way at the R.A.E. since the summer of 1953.

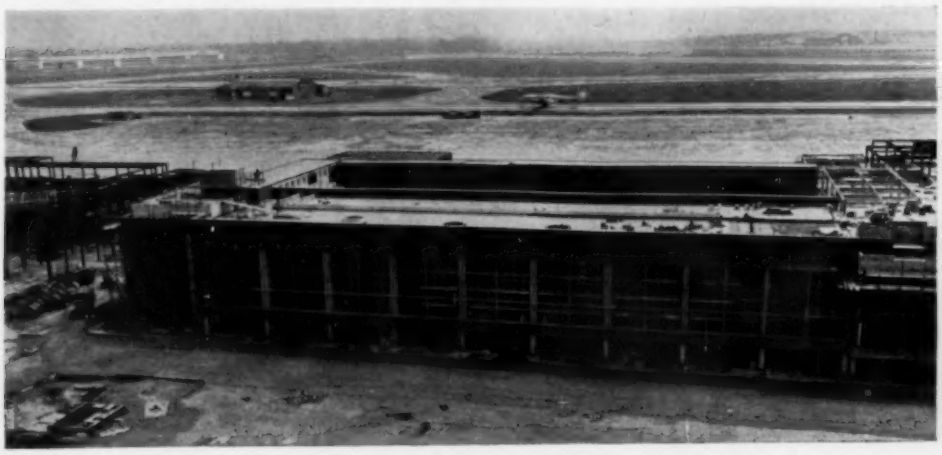
On April 29th a British minesweeper and two Italian trawlers resumed the search for wreckage of G-ALYP, which descended into the Mediterranean off Elba on January 10th. The original salvage operation, called off the day before the loss of G-ALYY, resulted in the recovery of 80 per cent of the wreckage. With the exception of the fin, the tail unit has still to be found.

Production of Comet 2s has virtually ceased, but work is continuing on the almost complete Comet 3 prototype, which is due to fly later this year. At Hatfield, a number of Series 2s which had almost reached the flight-test stage are being completed, but, temporarily at least, all test flying has stopped. De Havilland employees engaged in Comet production at Hatfield and Chester are being transferred to work on Vampire Trainers, Venoms, Doves and Herons. Other steps taken by the manufacturers include a reduction in overtime working, the closing down of a de Havilland training school at Hatfield—not the Aeronautical Technical School—and the suspension of sub-contracts for manufacture of Comet components. At Belfast, where Short Bros. and Harland, Ltd., had expected to produce their first Series 2 by July, Comet production has ceased and 800 of the 1,500 employees engaged on this work were given notice last week. Redundancy at Belfast was discussed in the House of Commons last Monday. Answering a supplementary question, Mr. Duncan Sandys, Minister of Supply, commented that it should not be assumed that the suspension of work on the Comet would necessarily be a lengthy one.

Civil operations which have been immediately affected by the grounding of Comets are, of course, those of B.O.A.C., Air France and U.A.T. Constellations are operating the Air France Comet services and DC-6s have taken over on the U.A.T. routes. B.O.A.C. are taking initial steps to make up for the loss of capacity caused by withdrawal of the Comets. Since April 10th the Corporation's South American services have been suspended to release Argonauts for the African and Eastern routes formerly flown by Comets. In an effort to ease this situation, B.O.A.C. have been discussing with Qantas and S.A.A. the possibilities that, on the respective Kangaroo and Springbok partnership services, these Commonwealth airlines should temporarily make available additional capacity or, alternatively, aircraft. It has been suggested that as Qantas are taking delivery of Super Constellations, B.O.A.C. might take over some of the Australian company's six Constellation 749As. However, it had already been agreed that these aircraft should be returned to Lockheed in part payment for the L.1049s; consequently B.O.A.C. might have to pay dollars for the earlier Constellations. Expressing confidence that the cause of the setback to the Comet will be discovered and remedied, the Corporation states positively that it is not contemplating the direct purchase of aircraft from the United States.

On April 16th Japan Air Lines announced that they had asked de Havillands to delay delivery of their two Comet 2s until 1957. The airline said that this request was not connected with the recent accidents: since placing the order J.A.L. had discovered that, in addition to the cost of the aircraft, it would be necessary to spend £2m on runway construction and pilot training; the company could not expend such a sum at this time.

"Flight" photographs



AIR O.P.: This recent view from the new L.A.P. control tower (above) shows part of the south-east face of the pear-shaped terminal area, where work is going ahead on the new passenger building (right). On the extreme left can be seen the framework of the "eastern apex" building, which will house airline offices and public amenities. Both buildings will be topped by an interconnected spectators' deck overlooking the marshalling apron.

CIVIL AVIATION . . .

WEST AFRICAN SAFARI

THE inauguration of the new West African "Safari" coach-class service, operated jointly by Airwork and Hunting Clan, has been postponed until June 14th. The delay is stated to be due to unavoidable difficulties outside the companies' control in the completion of the arrangements for the start of the new service.

From June 1st, fares on the existing Safari service between this country and East Africa, and to intermediate points, are to be increased. The normal adult single fare from London to Nairobi will be £97 instead of £92, and the return fare will increase from £166 to £175. As in the case of the fare increases on first-class and tourist-class services between Britain and East Africa, this latest increase is due to the rising costs of operation. The Safari services continue to provide the lowest available fares on this route.

NEW SERVICES APPROVED

IT is announced that the Minister of Transport and Civil Aviation, after considering the recommendations of the Air Transport Advisory Council, has approved the operation of the following new services:—

1. An internal service between London (Croydon) and Birmingham (Castle Bromwich) by Olley Air Services, during the period 3rd-14th May, 1954.
2. A normal scheduled service on the route London-Nice and/or Naples-Malta, by B.E.A., until March 23rd, 1961.
3. A normal scheduled service on the route London-Oslo-Stockholm, by B.E.A., until March 18th, 1961.
4. A normal scheduled service on the route London-Montreal-Chicago (optional) or London-Prestwick or Shannon-Keflavik and/or Gander-Montreal-Chicago (optional), by B.O.A.C., until February 22nd, 1961.

NEW T.W.A. BASE

AN agreement has been signed between T.W.A. and the local authorities of Kansas City for the construction of a new overhaul base at the city's new industrial airport site, 16 miles north-west of the present municipal airport. The $18,000,000 (approximately £6,500,000) cost of the base will be met by the sale of revenue bonds, and construction is to commence by July 15th this year.

The facilities of the new base will consist of three buildings: a main overhaul and office building, an engine overhaul building and warehouse, and an engine test house. Completion of the engine overhaul shops is scheduled for September 1st next year, and the entire base is to be completed within 720 days after the signing of the lease. The north-south runway of the new airport is expected to be ready for use by the time the overhaul base is completed.

SPRING OUTFIT: Boeing have decided on a colour scheme for the Model 707 jet transport/tanker demonstration prototype—primrose, white and chocolat-au-lait. The aircraft, shown in model form, will be "rolled out" this month and the first flight is scheduled for mid-June.

BREVITIES

WORK began recently at Prestwick on the airport's new 6,000ft runway, which will take two years to complete.

* * *

It is reported from Peru that detailed proposals for a merger between Pan American-Grace Airways and Braniff International Airways will be submitted to the C.A.B. within the next three months.

* * *

Construction of an underground rail link between the centre of London and London Airport was recently urged by the general manager of Thos. Cook and Son, Mr. James Maxwell. He suggested that an additional tunnel to the present Piccadilly Line, making possible a 20 minute non-stop journey to or from L.A.P., could be a worthwhile investment, assuming a single fare of 5s per person.

* * *

Formerly commander of the Aviation Bureau of the New York Police Department Emergency Division, Captain Gustav Crawford has joined the flying staff of Mohawk Airlines. Last week this company became the first U.S. local-service airline to take delivery of a helicopter—a Sikorsky S-55. During his service with the New York police, Captain Crawford received several commendations for saving lives in helicopters, on which he has flown 1,000 hr.

* * *

The East German Republic is reported to be setting up an airline, equipped with Russian aircraft, for domestic and European international services.

* * *

Six airlines recently moved nearly five tons of turbine parts to the Far East on behalf of the General Electric Co., Ltd. The parts were required at Hiroshima for the T.E.V. *Empire Wallace*, a cargo ship. An initial load of 5,947 lb was taken from Croydon to Geneva by Transair Dakota, thence by Skyways York to Bangkok, and from Bangkok to Tokyo by Thai Airways Skymaster. The remaining 2¼ tons were separated into three lots and sent by scheduled B.O.A.C., P.A.A. and S.A.S. passenger-freight service from London to Tokyo.

TRANS-WORLD OVERHAUL: An artist's impression of the proposed T.W.A. maintenance base at Kansas City (see news item on this page).

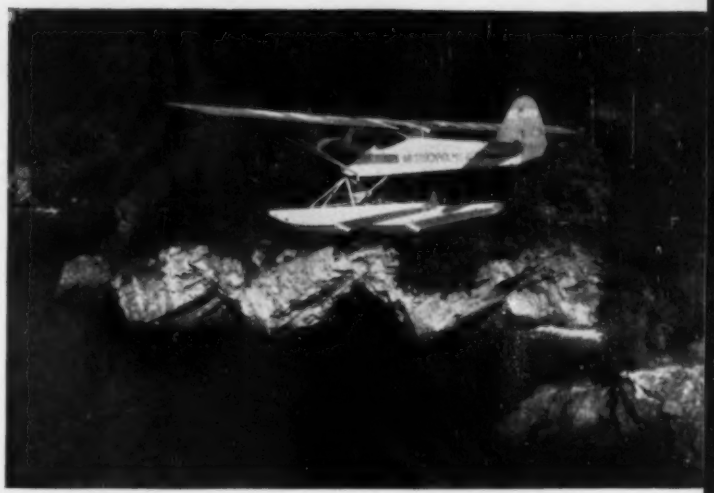
Record traffic is expected at London Airport during the coming summer and special arrangements are being made to accommodate parked aircraft. When the Bath Road apron is full additional airliners will be parked on both sides of the eastern end of runway 10L/28R. Parking procedures are fully described and illustrated in *Civil Aviation Information Circular* No. 56/1954.

* * *

The Aeronautical Engineers' Association has announced the distribution of log books designed to provide a handy and accurate statement of their members' engineering experience. Subject to the observance of certain instructions, the log book is accepted by the A.R.B. and by civil authorities of 22 Commonwealth and foreign nations. The book is bound between stiff blue covers and contains a photograph of the holder; the log itself is in three sections dealing respectively with licences held, previous experience and current experience.

* * *

More than 80 multi-engined executive and airline transports, with a total value exceeding £5m, have been sold since 1949 by William C. Wold Associates, an American company specializing in transport aircraft sales. The simple but highly successful Wold technique centres on the production of a small brochure describing the aircraft, which is circulated to a mailing list of 7,000 company executives, pilots, purchasing agents, export and import firms and operators, both in the U.S. and abroad. A typical offering described in the latest Wold brochure is a 300-m.p.h. Douglas B-26 Invader conversion with a luxurious five-seat cabin and toilet.



FLOATOCRAT: Points of interest on this nautical-looking J.1 Autocrat are the paddle attached to the port float struts and the water rudder (in beaching position) on the port float. The operators are A. B. Stockholms Aero, who have recently bought an Auster J.5G Autocar and a civil Mk. 5.

CLUB AND GLIDING NEWS

AS in previous years, the last Saturday in May has been chosen for the Ragosine-Auster Homing Trophy Competition at Rearsby. May 29th is this year's date, and the competition is to be run on lines similar to those of previous years. The course will be a closed circuit of 100 to 120 miles, and points will be awarded for precision in navigation and observation. All Auster pilots have been invited to take part: there is no entry fee, and application forms can be obtained from the Competition Secretary of the Auster Flying Club, Rearsby, Leicestershire.

Other Auster news is that the J.5F Aiglet Trainer has now been approved by the Air Ministry for A.T.C. flying training. The company states that the Aiglet is the only aircraft other than ex-military types to obtain this approval.

ANOTHER "type" event, also scheduled for May 29th, is the rally for civil aircraft of Percival manufacture, to take place at Luton Airport. There will be a sealed-time arrival competition between 3 and 3.30 p.m., followed by a *concours d'élégance*, demonstration of current Percival aircraft, prize-giving and tea.

Between 40 and 50 aircraft are expected to attend the rally, out of a total of 149 Percival machines on the British Civil Register. Among those present will be G-ADPR, Jean Batten's record-breaking Gull, and (it is hoped) G-AEXF, the last of the racing Mew Gulls, now owned by Fred Dunkerley.

"AT HOME" at Newtownards Aerodrome on July 10th will be members of the Ulster Flying Club, who state that visitors will be welcome any time from Friday, July 9th, onwards. There will be competitions for time of arrival and spot-landing, a cocktail party, and an informal dance in the clubroom. Accommodation will be available for guests, who are asked to contact the secretary of the club, Mr. George Wynne-Eyton, as soon as possible. Further details, also, can be obtained from the secretary, at Newtownards Aerodrome, Newtownards, County Down, Northern Ireland.

AMONG the recipients of gliding awards at the recent annual meeting of the Soaring Association of Canada were Stan Rys, the "annual meet champion," and Frank Brame, representing the Toronto Gliding Club, which won the club efficiency award. Stan Rys, it may be recalled, was previously a member of the London Gliding Club at Dunstable, while Frank Brame spent two years in this country from 1950 to 1952, when he was a member of the College of Aeronautics Gliding Club at Cranfield. At the Canadian meeting, the "Spike" Trophy for the longest flight of the year (256 miles), and the Canadair Trophy for the best five flights in 1953, were presented to A. M. Pow, of London, Ontario, who is to represent Canada in the world contests at Great Hucklow this summer.

NEW STYLES IN ULTRA-LIGHTS: (Left) This 20ft-span triplane, designed by George Frisbee of Milwaukee, U.S.A., is intended for kit production by amateur constructors, following present flight tests. (Right) Another American idea for cheap flying is the 86 lb Bensen "Gyro-glider" which, towed behind a car, takes off at about 20 m.p.h. A reader's letter suggesting rotating-wing ultra-lights appeared in "Flight" of April 23rd.

AT THE B.I.F.

Some Castle Bromwich Exhibits of Interest to the Aircraft Industry

ON Monday last the British Industries Fair opened in Birmingham (Castle Bromwich) and London (Olympia and Earls Court); it remains open until May 14th. For London, this will be the last B.I.F. under the existing organization by the Board of Trade, as future Fairs are to be taken over by a newly formed corporation; but the Midlands section will continue to be staged by Birmingham Chamber of Commerce in collaboration with the B.o.T.

As usual, Castle Bromwich houses the majority of the engineering exhibits, shown by over 1,000 firms. As usual, also, a tour of the Birmingham stands brought recognition of the names of many firms well known in the aircraft industry, though purely aeronautical exhibits were rare, for members of the S.B.A.C. largely reserve such items for Farnborough.

Standard Telephones and Cables, however, in a display of their work in a wide field of telecommunications, are featuring the STR. 9X ten-channel V.H.F., and PV.1B D/F., equipment as used to control the Coronation fly-past over London; and we learned that the R.A.F. has asked for a similar set-up to be installed near Woolwich for the Royal Homecoming Fly-past.

Other essentially aeronautical exhibits which the Castle Bromwich visitor may notice include a 7in contra-rotating (i.e., flow-straightening) air fan for the Viscount, on the stand of the Airscrew Co. and Jicwood, Ltd.; a complete Proteus engine and a Centaurus 661 mounting ring (rubber-to-metal bonding by Spencer Moulton), on the stand of the Bristol Engineering Manufacturers' Association; a sectioned Derwent on the Rolls-Royce stand; and, on the stand of Evertaut, Ltd., a Merlin exhaust manifold, typifying their fabrication work.

Some small airframe components showing the application of high-speed finishes and chromate primers are to be found in the Cellon stand, and—a pygmy among giant electric apparatus—there is an aircraft actuator in the English Electric exhibit.

Shown for the first time, the Rover 60 h.p. industrial gas turbine is attracting a great deal of attention, a sectioned example emphasizing the simplicity of the single combustion-chamber and tiny (by aircraft standards) centrifugal compressor.

I.C.I. Metals, on a stand which is perhaps the most technically instructive in the whole show, are featuring the latest progress in wrought titanium development; and I.C.I. associates in the B.I.F. include Marston Excelsior, with their heat-exchanger and flexible-tank products; the I.C.I. "Terylene" Council, stressing the value of "Terylene" polyester fibre as, *inter alia*, a lightweight insulator; and I.C.I. Plastics, of Perspex fame. Titanium is seen again in special exhibits by two firms of the Laporte Chemical group.

The "little horses" that work in portable tools are the main theme of a gay roundabout-and-fair-ground display by Desoutter Brothers.

Geo. Salter and Co., Ltd., are featuring, amid every imaginable size and shape of spring, their "Truarc" retaining rings; Jenks Brothers, Ltd., have a most impressive display of "Britool" hand tools, including a new range of five torque wrenches from 8 to 500 ft lb; the Pyrene Co., Ltd., are showing fire-fighting equipment for almost every conceivable situation; Autoset (Production), Ltd., are again exhibiting their comprehensive range of castors, together with engineers' clamps and other works equipment; Philidas, Ltd., have their self-locking nuts—widely used by the aircraft industry—on a stand which also displays the ball, roller and other bearings made by Pollard Bearings, Ltd.; and—recalling the pre-war aviation industry—the names Heston and Phoenix are linked again in the exhibit of the Heston Group, whose products include passenger steps and other aircraft ground equipment.

A wing leading-edge is to be seen on the stand of Hordern-Richmond (Sales), Ltd., in a display illustrating the use of Hy-Du-Lignum for press tools; Flexible Drives (Gilmans), Ltd, give pride of place to their "Six-star Flexmaster" multi-purpose flexible-shaft machine, demountable for floor, bench or suspended installation; Thomas Smith and Sons of Saltley, Ltd., have an impressive display of hand tools, and of drop forgings in steel and light alloys; and Wellworthy, Ltd., show, in addition to pistons and associated components and castings, "Wellseal" jointing compound and components produced by the Al-Fin process of chemically bonding aluminium to iron or steel.

Some interesting applications of resilient mountings for heavy-duty machinery are shown by L. H. Newton and Co.. Ltd., and photographs on the stand show that the test-cells of a leading gas-turbine manufacturer have been thus equipped; these "Seetru" bolts incorporate rubber bonding which both provides expansion-fixing in floor or wall and also gives a resilient mounting.

Apart from the spring products for which they are so well known, Herbert Terry and Sons, Ltd., are this year showing their range of "Security" A.G.S. 1000 worm-drive hose clips. The Dunlop aviation division is represented by a display of flexible piping for hydraulic and pneumatic applications; the Owen Organization have exhibits typical of their products, which range from aircraft small parts to Conveyancer fork-lift trucks; W. H. Paul, Ltd., show examples of their steel fabrication work, among customers for which are Rolls-Royce, Ltd.; Guest, Keen and Nettlefolds (Midlands), Ltd., are again at the show, their products including "Aerotight" stiffnuts; Garringtons, Ltd., show hand tools and forgings (they are large-scale producers of gas-turbine blades, forged by the upsetting process); Hilmor, Ltd., show tube-bending equipment that should interest the aircraft industry; Sciaky Electric Welding Machines, Ltd., demonstrate their range of spot and stitch welding equipment, widely used by manufacturers of aircraft components; and among other exhibitors in the electrical section are Clang, Ltd., who are A.I.D.- and A.R.B.-approved for electrical small parts.

Samuel Fox and Co., of the United Steel Companies, are making a point of their recent achievements in the manufacture of clock, and watch and instrument springs, until recently a virtual monopoly of the Swiss; the Saunders Valve Co., Ltd., are again displaying their diaphragm valves, well known in aircraft applications; Thompson Brothers (Bilston), Ltd., of refueller fame, are represented in the show; Tufnol, Ltd., are demonstrating applications of the versatile material of that name; Westinghouse Brake and Signal Co., Ltd., are showing the "Westruk" 960 rectifier equipment for aircraft ground starting and servicing, as recently described in *Flight*; B.O.A.C. are reminding industry of the advantages of air travel; and Associated Iliffe Press (Stand D216) are ready to tell visitors about technical journals and other publications to serve their specialized needs.

Very many other exhibitors at Castle Bromwich are, of course, makers of products used by the aircraft industry. In addition to those mentioned above, for example, there are:

George Angus and Co., Ltd.; Auto Diesels, Ltd.; BX Plastics, Ltd.; Bakelite, Ltd.; Benton and Stone, Ltd.; Thomas Bolton and Sons, Ltd.; Bolton Gate Co., Ltd.; British Ermeto Corporation, Ltd.; British Insulated Callender's Cables, Ltd.; British Manufactured Bearings, Co., Ltd.; British Ropes, Ltd.; British Tyre and Rubber Co., Ltd. (whose engineering division, it was announced last week-end, has been acquired by J. Stone and Co., Ltd., of Deptford and Charlton); Chance Brothers, Ltd.; P. B. Cow and Co., Ltd.; Distillers Co., Ltd.; J. H. Fenner and Co., Ltd.; Firth Vickers Stainless Steels, Ltd.; Fletcher Miller, Ltd.; H. Fisher (Oldham), Ltd.; Gulf Oil (Great Britain), Ltd.; General Electric Co., Ltd.; Hall and Hall, Ltd.; Joshua Hindle and Sons, Ltd.; Ioco, Ltd.; Jenolite, Ltd.; Kleen-e-ze Brush Co., Ltd.; Lansing Bagnall, Ltd.; Arthur Lee and Sons, Ltd.; Joseph Lucas, Ltd.; M.C.L. and Repetition, Ltd.; Manchester Oil Refinery (Sales), Ltd.; Mavitta Drafting Machines, Ltd.; Metal Processes, Ltd.; Midland Silicones, Ltd.; Exors. of James Mills, Ltd.; Monsanto Chemicals, Ltd.; B. O. Morris, Ltd.; David Moseley and Sons, Ltd.; Multiform Structures, Ltd.; New Welbeck, Ltd.; Newton Brothers (Derby), Ltd.; Oldham and Sons, Ltd.; Palmer Tyre, Ltd.; Phipps Plastic Products, Ltd.; Plastic Engineers, Ltd.; Precision Metal Spinnings (Stratford-on-Avon), Ltd.; Revo Electric Co., Ltd.; Rotherham and Sons, Ltd.; Rozalex, Ltd.; Joseph Sankey and Sons, Ltd.; Serck Tubes, Ltd.; Shell-Mex and B.P., Ltd.; Siebe, Gorman and Co., Ltd.; Sorbo, Ltd.; Tilley Lamp Co., Ltd.; Ronald Trist and Co., Ltd.; James Walker and Co., Ltd.; Wayne Tank and Pump Co., Ltd.; Wolf Electric Tools, Ltd.; Wrights' Ropes, Ltd.; Yorkshire Copper Works, Ltd.

"WINGS FOR THE WORLD"

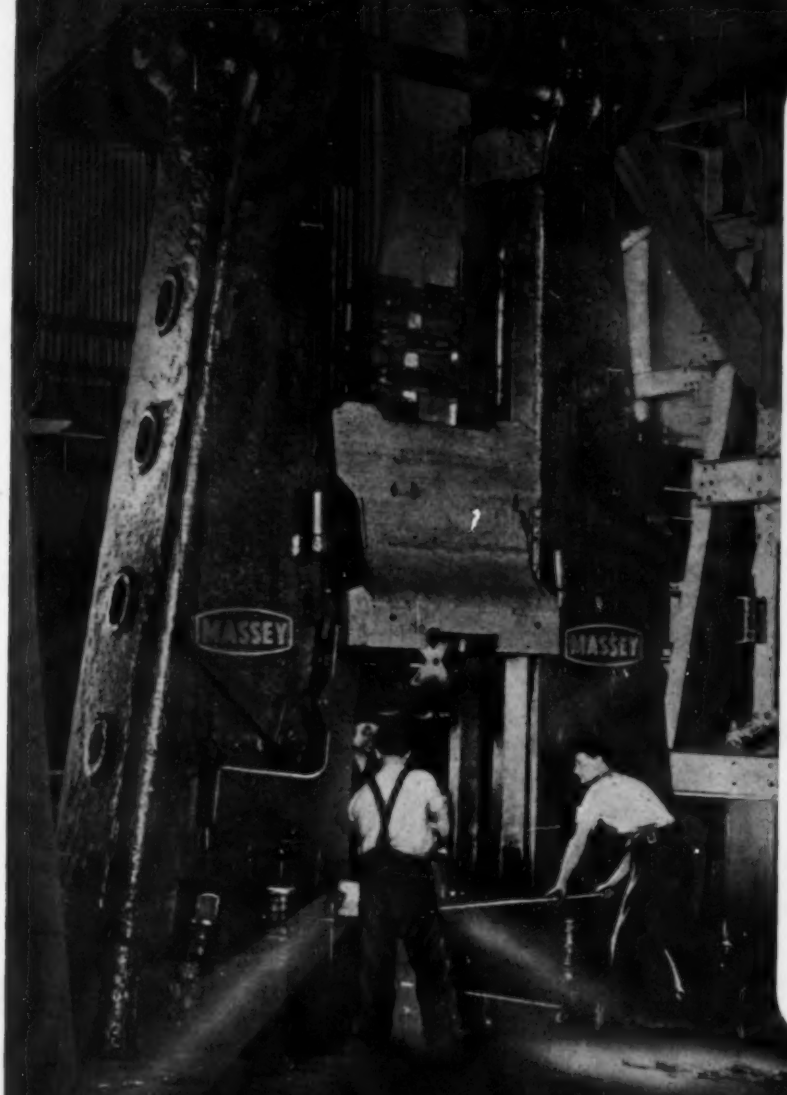
WITH the above title, an aviation film produced by the Esso Petroleum Company was recently shown for the first time in London. It consists mainly of pictures taken at last year's S.B.A.C. show at Farnborough, together with a short general introduction concerning this country's postwar bid for exports and the development of the Viscount and Comet.

The photography, which is in colour, is excellent, and in particular the air-to-air views taken from the M.o.S. Packet are admirable. Regrettably, the commentary and the background music are not of this high standard. While not wishing to be over-critical of a film which is not intended for the aviation specialist, we believe that most readers of *Flight* would be disappointed in the loose, over-dramatic commentary, and irritated by the terribly "bright" yet very wearing musical acompaniment.

The ideal solution for the aviation enthusiast able to see this film, we feel, is that he should take along a pair of earplugs. If he is anything of a purist, he should also blink his eyes as the Pioneer changes in mid-air into a Beaver. Then he will undoubtedly enjoy this film.

K. T. O.

TURBINE DISCS and COMPRESSOR WHEELS



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grateful thanks from my wife and myself to you and your colleagues who assisted in getting my daughter and son-in-home f ika, which by now you will have learnt t safe heir journey at Blackbushe yesterday aft noo re you we are most grateful to you all Fro ed by my daughter and her husband there no d that this service of yours is to say the least ful. They both speak most highly of the c on extended to them by all on board ar en route. What is more, I feel perh might

AIRWORK like to know t t nature from journey, these coming from folk w used your service before.

When my daughter went out last yea and

PASSENGERS trave out on an organisation other than yo feel that hey are perh in quite a good sition

AIR THEIR to judge. Th re only remain now for you to le indebtedness to and I when

OPINIONS I wi ue by return

my husband and I would like to bring to your notice the quite exceptional efficiency of the air hostess on the Viking in which we flew to Wadi Seidna last Friday October 19th.

I feel that if thi your usual standard you to be congratulated at having arrived at a very high standard indeed. It would be a real pleasure to be able to look forward to the same crew

having just completed a return journey to Nairobi in your line, I would like to place on record my appreciation for the excellent arrangements made for passengers at halting places on the way

I was most favourably impressed with all the arrange ments that were made, with the service of your personnel and with the efficiency attending the flights, and I should like you to know that these special

I arrived at BLACKBUSHE in your flight from Karachi, Pakistan yesterday and would like to let you Know how efficient I thought the Service was. Everything over which the crew had control

AIRWORK LIMITED

The above are extracts from original letters which can be seen on request at 15 Chesterfield Street, London, W.1.

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AIR TRANSPORT DIVISION

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

ADEN INVESTITURE: The Queen giving the accolade to Air Marshal C. B. R. Pelly at a levee held during her short stay in Aden on the way home from the Commonwealth tour. Air Marshal Pelly is Commander-in-Chief Middle East Air Forces. His promotion in the Order to Knight Commander of the Bath was announced in the New Year Honours.

Malta Memorial Unveiled

ON Monday last the Queen unveiled the Malta memorial to the men of the Air Forces of the British Commonwealth and Empire who died during operations in the central Mediterranean area and who have no known graves.

Speaking at the unveiling, the Queen said: "Most of you will inevitably be turning your minds back, recalling past memories and wondering perhaps whether their sacrifice has been in vain. To you I would give this message of hope—if we show in all our dealings the same integrity of purpose and same resolution in fulfilling it as was shown by them in war, then surely we shall be able to extract from the dark and desperate difficulties which still beset us a victory no less glorious than that which we commemorate here today."

At the conclusion of the ceremony the Queen and Duke both laid a wreath and inspected the plaques on which are engraved the names of the 2,301 men the memorial commemorates.

The Air Minister, Lord De L'Isle and Dudley, accompanied by Lady De L'Isle and Dudley, flew to Malta in a Viking of the Queen's Flight. In the aircraft also were Air Chief Marshal Sir Francis J. Fogarty and Lady Fogarty. Sir Francis represented the Chief of the Air Staff, Air Chief Marshal Sir William F. Dickson.

Two other R.A.F. aircraft carried a number of notabilities including the following: Air Chief Marshal Sir Ronald Ivelaw-Chapman and Lady Chapman, Marshal of the R.A.F. Lord Newall and Lady Newall, Marshal of the R.A.F. Lord Tedder (President of the R.A.F. Association) and Lady Tedder, Air Chief Marshal Sir A. Guy Garrod, Air Chief Marshal Sir Hugh P. Lloyd and Lady Lloyd, Air Chief Marshal Sir Robert M. Foster and Lady Foster, Air Marshal Sir H. E. Philip Wigglesworth, A.V-M. F. H. M. Maynard and Mrs. Maynard, A.V-M. Sir John Cordingley (Controller of the R.A.F. Benevolent Fund), the Rev. Canon A. S. Giles, and the Rev. T. Madoc-Jones.

I.A.F. COLOUR: President Prasad presenting his Colour to the Indian Air Force on the occasion of its coming of age last month. Behind him is Air Marshal Mukerjee, the Chief of the Air Staff. The ceremony took place at a parade held on Palam airfield, near New Delhi.

"Ark Royal"

ON Sunday last the Royal Navy's new aircraft carrier, H.M.S. *Ark Royal* (36,800 tons) left the fitting-out basin of Cammell Laird's in Birkenhead for the Gladstone Graving Dock at Liverpool. The four-mile journey took some two-and-a-half hours to complete. On the way, in the charge of 12 tugs and in a high wind, she was involved in three minor mishaps. On leaving Birkenhead the starboard side scraped the quayside, crushing a ventilator and shearing a number of bilge outlet flanges. When entering Gladstone Dock the port side of the carrier swung against the quay, splintering a fend-off and scraping off a patch of paintwork amidships. Finally, as she rounded the lead-in to the dry dock, the starboard side was again grazed against the quay. A one-inch hawser snapped and more paint was scraped off.

It is 11 years since building first started on the *Ark Royal* at Birkenhead. The cost over that period is £25 million.

Royal Visit to Germany

BETWEEN July 12th and 15th, Her Royal Highness Princess Margaret will pay her first visit to Germany and to R.A.F. and Army units stationed there. Her Royal Highness has accepted an invitation to lunch with Professor Heuss, German Federal President, on the first day.

Runnymede Memorial Service

IN commemoration of V.E. Day, a short ceremony of remembrance will be held at the Runnymede Memorial at 10.45 a.m. on Tuesday next. During the service Air Chief Marshal Sir William Dickson will lay a wreath on the Stone of Remembrance on behalf of the Commonwealth nations.

No special invitations are being issued but the Memorial will be open to the public as on other days throughout the year. It is proposed to make the service an annual ceremony.

Bomber Command S.A. Meeting

THE 7th annual Bomber Command small arms meeting is being held this weekend at the Purfleet ranges.

Air Marshal Sir George H. Mills will present the prizes at 11.45 a.m. on May 10th.

SERVICE AVIATION . . .

Inter-Services Rifle Match

FOR the eighth time since it was established in 1947, the R.A.F. have won the annual inter-Services small bore rifle match. With a score of 7,929 points the team beat their last year's record by 23 points. Other scores were: Territorial Army, 7,889; Home Guard, 7,880; Regular Army, 7,848; Royal Marines, 7,800; Royal Navy, 7,781 and R.N.V.R., 7,549.

AIRCENT Microwave Relay

TO provide reliable communications for the international air forces forming the AIRCENT command of NATO a microwave relay communications network has just been completed. The total cost is in the region of £3 million.

The microwave relay is beamed in straight lines, along the line of sight, and with the aid of relay towers, can cover long distances with little diminution of reliability. A number of such relay stations link the Fontainebleau H.Q. of AIRCENT to SHAPE and other NATO H.Q., thus making the command to some extent independent of commercial lines.

From each AIRCENT terminal point there are 24 channels, each of which can carry a conversation. Any one of these channels can be broken down into 16 two-way teletype circuits and these different types of message can be carried at the same time.

The new system is being operated under the command of W/C. P. H. S. Wood, O.B.E., R.A.F., who is Chief of the Radio Communications Branch at AIRCENT. It is expected that the big manœuvres contemplated this autumn will provide a severe test.

R.A.F. Appointment

THE announcement is made of the appointment of A. Cdre. F. J. St. G. Braithwaite, C.B.E., as A.O.C. No. 61 Group, Home Command, with the acting rank of air vice-marshal.

For rather more than two years A. V-M. Braithwaite has been Director of Plans at the Air Ministry and for a year before that he served on the Air Board, Military Standardization Agency.

At the outbreak of the last war he was at Coastal Command headquarters as a torpedo specialist, and throughout the war held a post connected with anti-shipping operations. He attended the 1950 course at the Imperial Defence College.

WAR GAME: Air Chief Marshal Sir William F. Dickson (left) in conversation with Admiral J. H. Cassidy and Vice-Admiral T. S. Combs of the United States Navy during a recent command post exercise at SHAPE headquarters. Both of the American admirals are wearing wings.

W.R.A.F. Appointments

TWO appointments in the rank of group officer are announced. G/O. A. Stephens, M.B.E., is to be Deputy Director of the W.R.A.F. and G/O. J. L. A. Conan-Doyle to be Inspector of the W.R.A.F. These two appointments are, in fact, a switch-over of duties. G/O. Stephens has been Inspector for the past two-and-a-half years and G/O. Conan-Doyle Deputy Director since November 1951.

For the R.A.A.F.

THE R.A.A.F., it is reported, has ordered 48 Canberras and additional Avon-Sabres from Commonwealth Aircraft Corporation, Melbourne.

Three of the Canberras have been delivered and four others are having final tests. Seventy-two Avon-Sabres are already on order. A prototype Avon-Sabre, first aircraft to dive at supersonic speed in Australia, has been undergoing extensive trials for several months.

New C.O. for B.U.A.S.

THE new commanding officer of Bristol University Air Squadron is S/L. J. H. Langley. He trained in Canada during the early part of the war and served with Fighter and Transport Commands during the war in Europe and the East; he returned to this country in 1947. Before taking up his Bristol appointment he was chief ground instructor at the Flying Training School, Tern Hill, Salop.

Biggin Hill Under Fire

THE airfield defence exercise at Biggin Hill, mentioned in these columns last week, duly took place in spite of poor weather conditions. Initial attacks on the airfield, supported by such noisy devices as thunderflashes, blank cartridges, and Meteors from North Weald, were concentrated mainly on the western and eastern boundaries. The principal attack, however, finally developed on the southern Downe Golf Course sector and the attackers gained some ground. Air battles took place over the airfield area. Communications systems, which were being particularly tested, are stated to have functioned satisfactorily.

QUITE CLEAR: Technicians of the Royal Australian Air Force undergoing a course of instruction at the Commonwealth Aircraft Corporation's factory at Fisherman's Bend are provided with a mock-up of the Australian-built Avon-Sabre fuselage fitted with removable panels of transparent plastic.

A.T.C. at Hendon

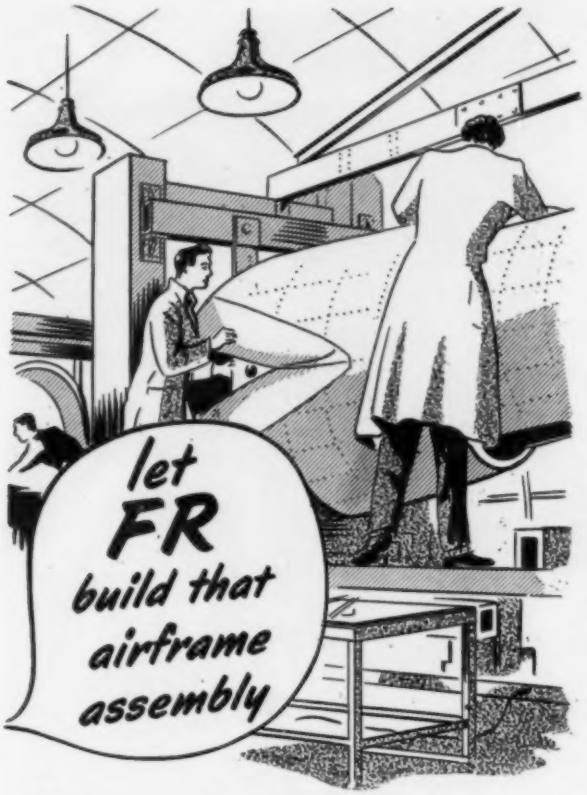
DURING the week 20th to 27th April, Air Training Corps cadets from the County of Middlesex Wing enjoyed holiday flying at R.A.F. Hendon. In this period no fewer than 567 cadets were given flights, totalling 363 hours. This outstanding performance was achieved only with the kind co-operation of G/C. R. C. Dawkins, C.B.E., the Station Commander, W/C. Southwell, D.F.C. and Bar, Wing Commander Flying, S/L. Williamson, D.F.C., O.C. No. 31 Squadron and the O.C. Com. Flight No. 61 Group.

All pilots on the Station willingly took cadets as passengers on every possible occasion, and the lads have visited such places as Leuchars, Kinloss, St. Eval, Chivenor and Aldergrove. Some of the flying was done by V.R. pilots who were glad to offer their services. The normal work of the Station proceeded without interruption.

Never before have so many cadets flown so many miles in a week from a single R.A.F. station.

Bomber Command Reunion

THE ninth annual reunion of the Headquarters Bomber Command Association of Officers is being held at Headquarters Bomber Command, Royal Air Force, High Wycombe, Bucks, on Saturday, May 22nd. Any member of the Association who has not received details of this reunion can obtain them by applying to the hon. secretary of the Association at the above address.



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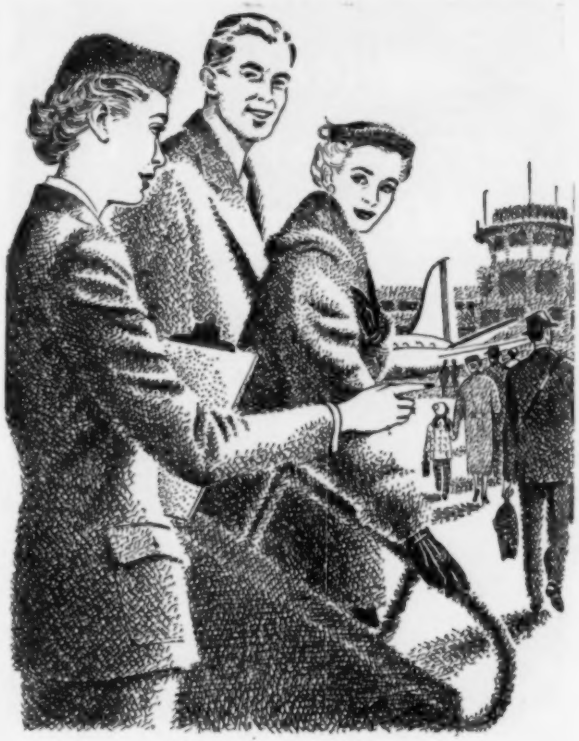

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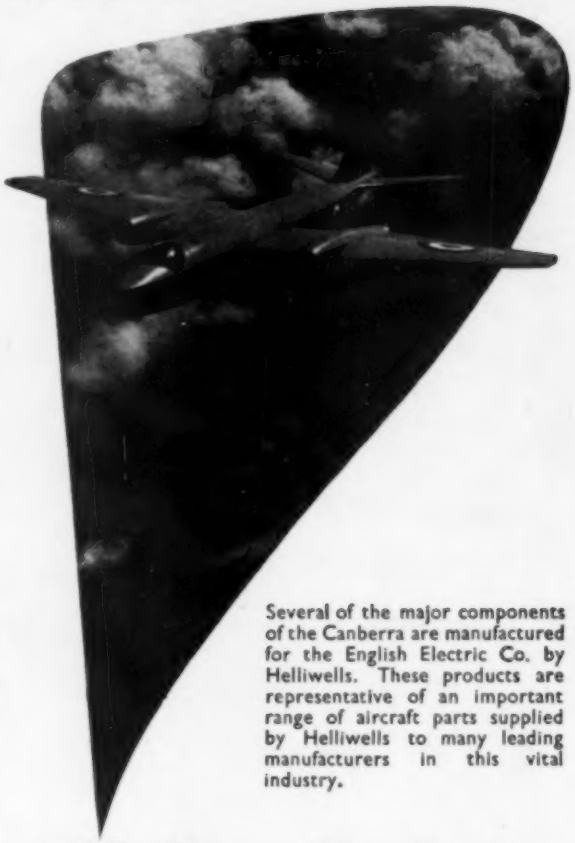

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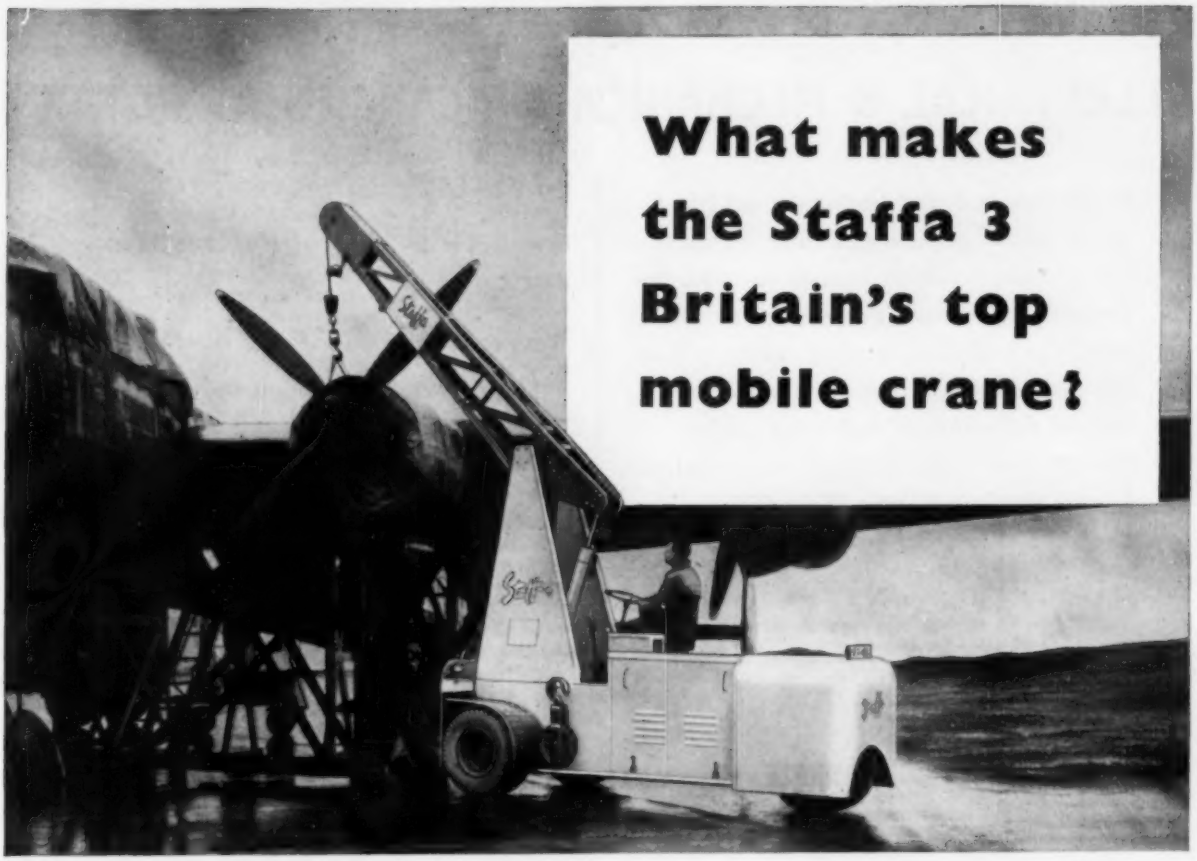

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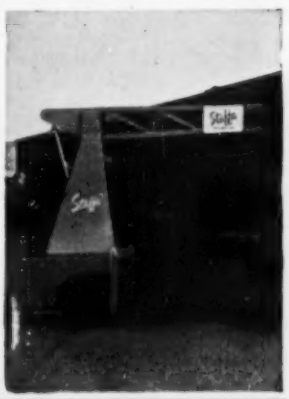

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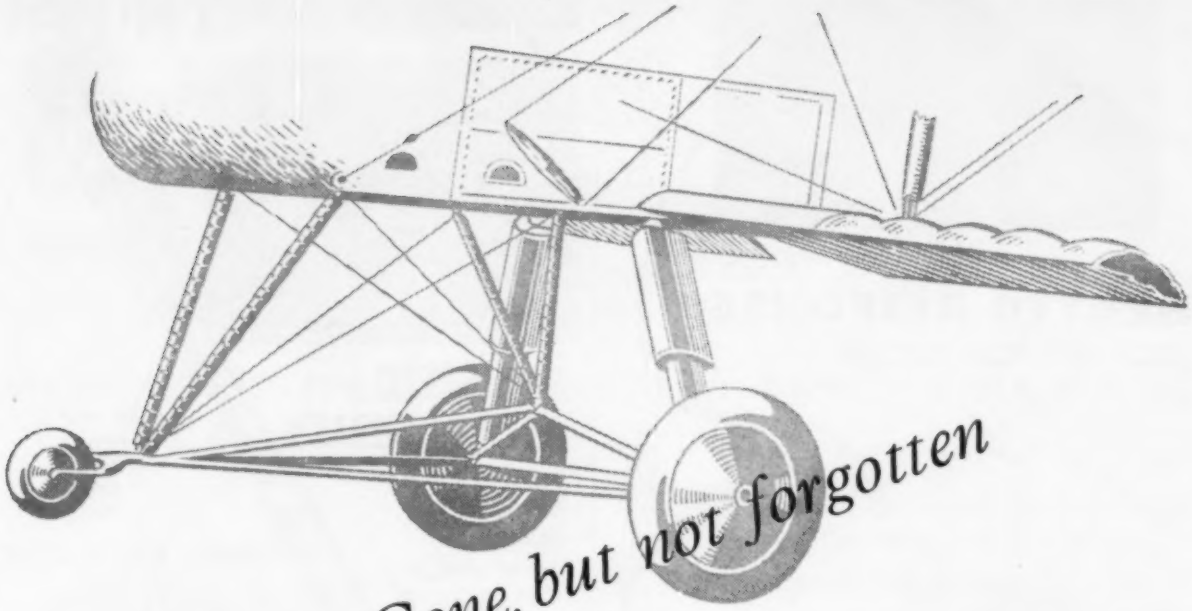

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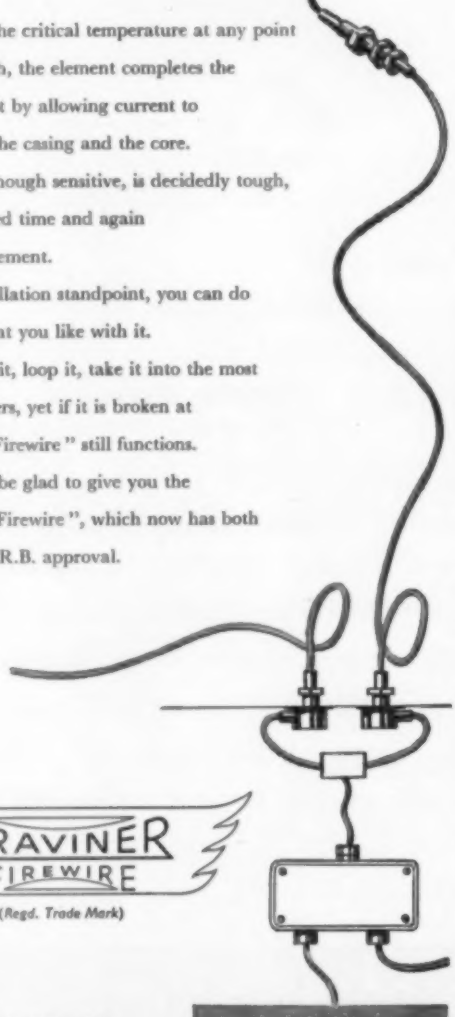

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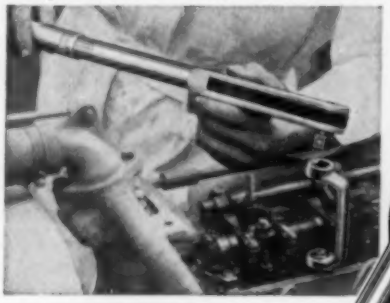

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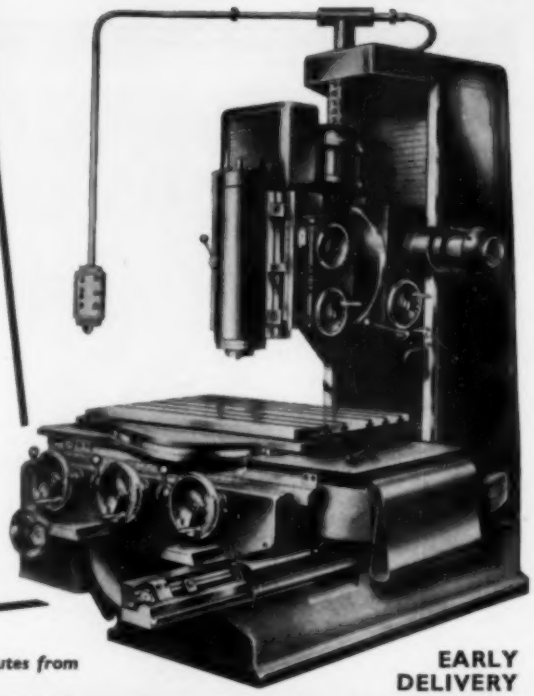

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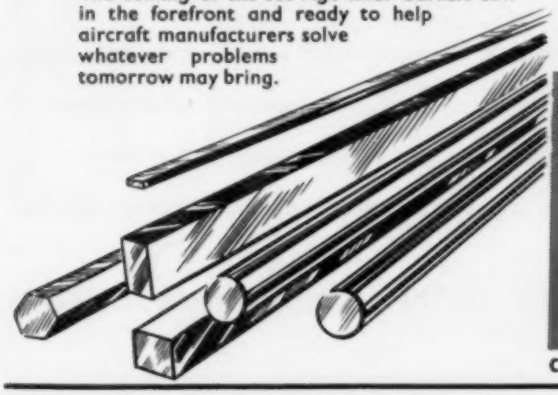

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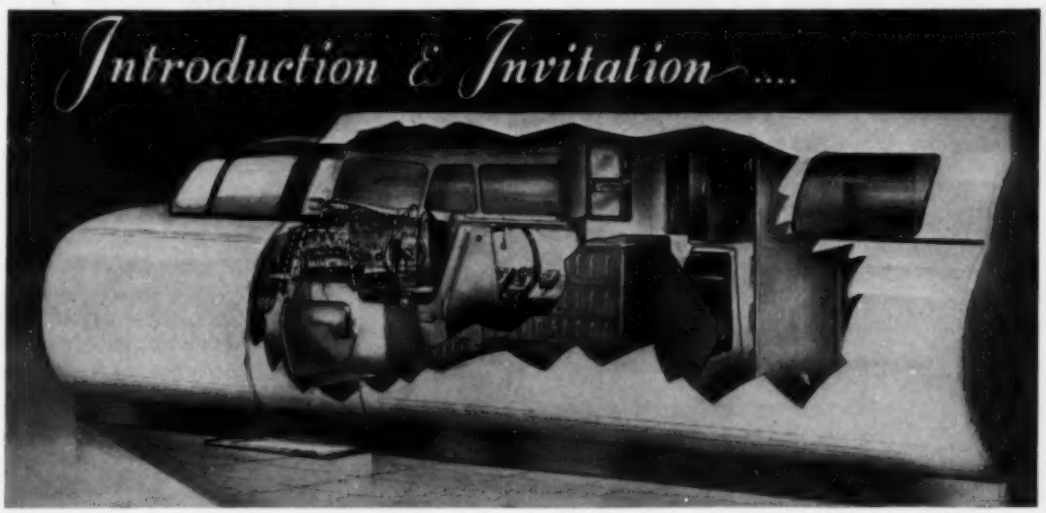

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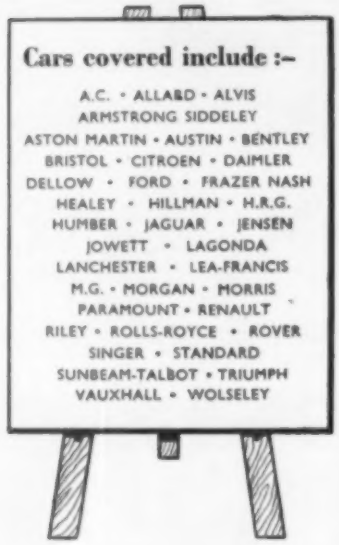
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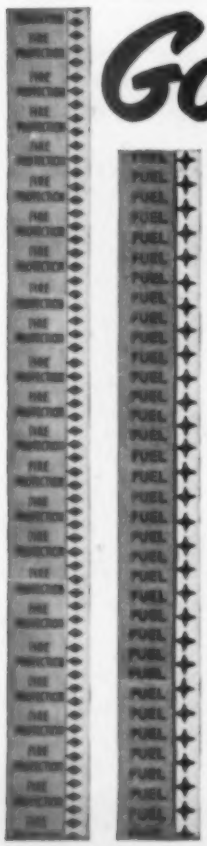

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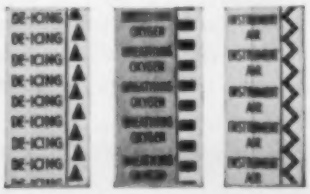

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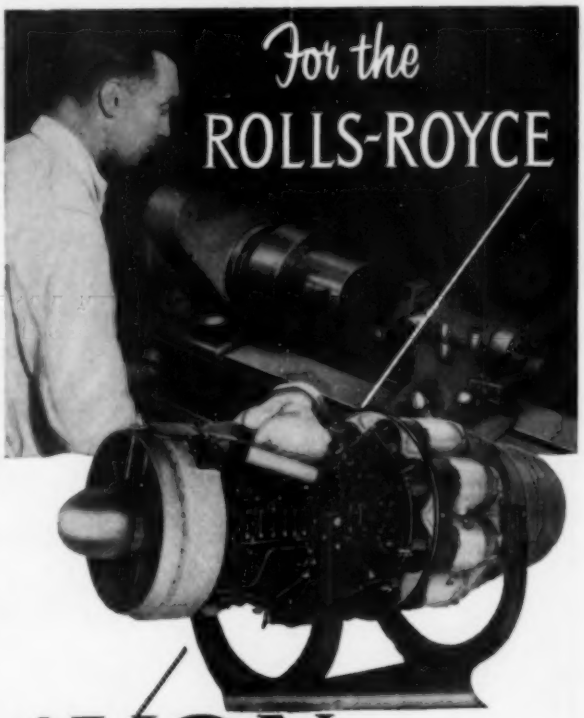

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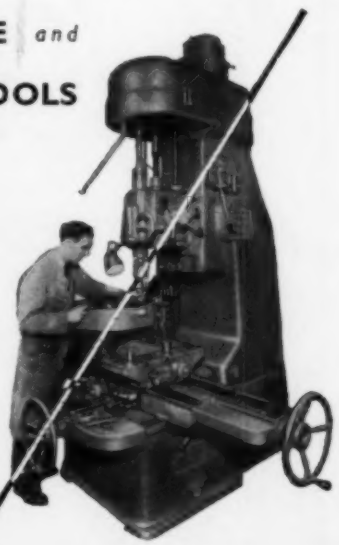

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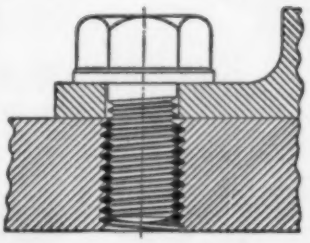

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seek to appoint technical staff in the following categories:

AERODYNAMICISTS

DESIGNER STRESSMEN

DESIGNER DRAUGHTSMEN

TEST HOUSE ENGINEERS

of degree or Higher National Certificate standard

and

WEIGHTS CONTROL ENGINEERS

LOFTSMEN

of ordinary National Certificate standard

required for interesting programme of work on super-priority projects.

THE positions available are permanent and pensionable and carry generous salaries with ample opportunity for advancement to progressive men.

WORKING conditions are good and in some cases the company are able to give assistance in housing problems.

INTERVIEWS may be arranged for Saturday mornings at Cricklewood or at a place near to the applicant's home if practicable.

APPLICATIONS, stating age, qualifications and full details of experience, should be sent to:

Staff Officer,

HANDLEY PAGE, LTD.

Cricklewood,
London, N.W.2. [1938

THE SUPERMARINE WORKS OF VICKERS-ARMSTRONGS, LIMITED

NOW IN PRODUCTION OF SUPER-PRIORITY AIRCRAFT, REQUIRE:

TECHNICAL ASSISTANTS

for structural analysis and structural testing. Qualification, degree or H.N.C. Previous experience of this work not essential.

AERODYNAMICISTS

Qualification: degree or equivalent standard. Some experience in aeronautical engineering desirable.

DESIGN DRAUGHTSMEN
(Senior and Junior)

Preferably with aircraft experience, but men with mechanical, structural or electrical experience also considered. Requirements are mainly for airframe design, but certain vacancies exist for work on wind tunnel models and equipment, and on aircraft instrumentation.

FULL-SCALE LAYOUT DRAUGHTSMEN
(Senior and Junior)

Preferably with aircraft experience.

JIG AND TOOL DRAUGHTSMEN

For designing machine fixtures, assembly tools and jigs.

Write, giving full particulars, including age and salary required, to Personnel Department, Hursley Park, near Winchester, Hants. [1935

AERODYNAMICISTS

A RAPIDLY expanding precision instrument manufacturing firm holding long-term design and development contracts has the following vacancies:

(a) Senior aerodynamicist with experience of dynamic stability analysis in connection with the design and development work of autopilots. Knowledge of servo mechanisms an advantage. Position offers exceptional opportunity for the right man. Ref. S.E./2.

(b) Young graduates and personnel with equivalent professional qualifications for training in the above field. Ref. G.E./2.

PLEASE forward full details of career and salary required (which will be treated in strict confidence), quoting appropriate reference, to Box 4582. [1994

ENGINEERS and technical assistants.

VACANCIES now exist in the research department of this company for qualified engineers and technical assistants to work on the development of electro-mechanical, hydraulic and electronic aircraft equipment. These positions offer unusual scope. Real ability and initiative are sought and will be recognized. Brief particulars of qualifications and experience should be sent in confidence to the Personnel Manager, Western Manufacturing (Reading), Ltd., The Aerodrome, Woodley, Reading, Berks. [1986

VICKERS-ARMSTRONGS LIMITED
WEYBRIDGE WORKS

GUIDED WEAPON DEVELOPMENT

Applications are invited from experienced ENGINEERS *for senior staff appointments in the following grades:—*

ELECTRONIC ENGINEER
—to lead Group on Servo Control and Simulator Design.

ELECTRO-MECHANICAL DESIGNER—to develop small mechanisms

Vacancies also exist for:—

ENGINEERS

TECHNICAL ASSISTANTS

DRAUGHTSMEN
(Senior, Intermediate, Junior and Trainee)

LABORATORY ASSISTANTS and MECHANICS

For work on structural, electronic, electrical and mechanical engineering development.

Suitable academic qualifications are required:

Engineers and Technical Assistants—graduate or equivalent.

Draughtsmen and Laboratory Assistants — H.N.C. standard.

Applications should be sent to:

EMPLOYMENT MANAGER,
VICKERS-ARMSTRONGS LIMITED
Weybridge Works, Weybridge, Surrey

SITUATIONS VACANT

FIXED AND ROTARY WING AIRCRAFT

We have immediate vacancies for:—

AERODYNAMICISTS
(Senior and Junior)

TECHNICIANS
(Senior and Junior)

for structural analysis and aeroelastic work.
Good working conditions.
Superannuation.
Salaries in accordance with experience.
Reply, giving full details, to:—
Personnel Officer,
WESTLAND AIRCRAFT, LTD.,
YEOVIL, SOMERSET. [1995

SILVER CITY AIRWAYS, LTD.

OPPORTUNITIES exist at Blackbushe and Lympne Airports for senior staff (technical) with current engine and airframe licences on Freighter, Dakota, Hermes aircraft.

WRITE for application forms and appointment to Engineering Superintendent, Blackbushe Airport, Camberley, Surrey. [1951

REQUIRED FOR SERVICE IN MIDDLE EAST

1. Aircraft maintenance foreman, minimum qualifications A and C licence with Dakota and P and W R1,830 endorsement. Salary £1,200-£1,250-£1,312-£1,375-£1,438 plus cost of living allowance, initially at £168 p.a. Post service benefit scheme. Eighty days paid leave in U.K. p.a. with free return air passages for employees and families.

2. Aircraft maintenance fitters with recent experience of Dakota aircraft. Salary £863-£900-£938-£975-£1,012 plus cost of living allowance, initially at £148 p.a. Other conditions as given above.

APPLICATIONS to Airwork Ltd., Overseas Division, Sutton Lane, Langley, Bucks. [1945

RAPIDLY expanding light engineering firm in south-west Glasgow has the following two vacancies:

PRODUCTION planner.

PROGRESS engineer.

ONLY first class men having considerable previous experience and knowledge of up-to-date methods need apply. All applications will be treated in strict confidence and applicants should write, stating salary required, and give full details of past history.—Box 5035. [1972

AIRWORK GENERAL TRADING CO., LTD., require a licensed engineer with A and C licences on Dakota aircraft, for service in Aden.

APPLICATIONS should be made in writing, giving details of past experience, etc., to the Service Manager, Airwork General Trading Co., Ltd., Blackbushe Airport, nr. Camberley, Surrey. [1919

ASSISTANT chief inspector required for aircraft factory in West Scotland. Must have five years recent experience similar capacity.

ATTRACTIVE salary, staff pension scheme, excellent welfare and canteen facilities.

APPLICATIONS, stating experience and age, should be addressed to Box 4955. [1960

AIRCRAFT captains are urgently required to serve three-year contracts with subsidiary companies of B.O.A.C. in the Persian Gulf area.

THE essential qualifications are an A.L.T.P. licence with Dakota and/or Dove endorsements.

THE gross emoluments comprise a basic salary and an attractive scale of allowances and are free of income tax. Furnished accommodation is provided but in certain areas married accommodation is not at the moment available. A nominal charge is made for the provision of accommodation. Free medical service and insurance are arranged and home leave at the rate of eight weeks for each year of service is granted.

APPLICATIONS should be addressed to Staff Manager, Subsidiaries, British Overseas Airways Corporation, Airways House, Brentford, Middlesex. [1979

PILOT required for W. German advertising firm. Good salary and bonus in Deutschemark. Accommodation available. Single man preferred.—Box 5036. [1978

SKYWAYS, Ltd., Stansted Airport, nr. Bishops Stortford, have vacancies for aircraft instrument mechanics. Hostel accommodation available.—Please apply Personnel Manager at above address. [1991

TECHNICAL assistant required by firm being established in north-east England to make important specialized product for aircraft, now successfully developed with good prospects.

EXPERIENCE as aircraft or component draughtsman is essential, together with an aptitude for technical administration, but no specialized design knowledge is required.

THIS is an invitation to a young man to join new organization at an early stage exercising initiative in wide sphere. House may be available. Write, giving all particulars, to Box 4879. [1936

SENIOR, intermediate and junior draughtsmen required for aircraft work of super priority. A.E.S.D. rates and upwards, depending on ability. Aircraft experience desirable but not essential. Apply, giving age and details of experience and salary required to Personnel Manager, Helliwells, Ltd., The Airport, Walsall. [1966

SITUATIONS VACANT

SERVICE engineers required for installation and trials of aeronautical and marine navigational equipment. Applicants must be of good appearance, prepared to travel in U.K. and have the following qualifications:
(a) Aeronautical: Under 35 years of age with electrical and radio theory to C. and G. Radio III standard.
(b) Marine: A.C. and D.C. electrical theory to approximately O.N.C. standard. Knowledge of electronics or radar preferable.
GOOD conditions; expense and travelling allowances; pension scheme.—Apply, with full details including salary, quoting No. 1477, to Personnel Manager, Sperry Gyroscope Co., Ltd., Great West Road, Brentford, Middlesex. [1955

JIG and tool draughtsmen for super-priority work. Good salaries and prospects. Pension scheme.—Full details to the Personnel Manager, The Fairey Aviation Co., Ltd., Hayes, Middlesex, quoting Reference PD/1. [1992

JIG and tool draughtsman (senior) required. Good welfare facilities including staff pension scheme.—Applications, in writing, to Personnel Manager, Percival Aircraft, Ltd., Luton Airport, Beds, stating age, experience and salary required. [0593

SENIOR and intermediate design draughtsmen, with good experience of aircraft or light structural or mechanical engineering, required for aircraft and armament project work.—Apply, by letter, to Portsmouth Aviation, Ltd., The Airport, Portsmouth. [0612

DRAUGHTSMEN required in the designs drawing office. These appointments are pensionable and offer good prospects to individuals with initiative and technical ability.—Applications should be sent to Personnel Manager, Joseph Lucas (Gas Turbine Equipment), Ltd., Shaftmoor Lane, Hall Green, Birmingham 28. [1982

TECHNICAL illustrators (male, senior) required. Considerable practical experience of illustrating for sales brochures and descriptive manuals essential. Good welfare facilities including staff pension scheme.—Applications, in writing, to Personnel Manager, Percival Aircraft, Ltd., Luton Airport, Beds, stating age, experience and salary required. [0592

H. M. HOBSON, Ltd., invite applications for positions in the drawing office as follows: designers, detail and modification draughtsmen, checkers, stressmen. The work is concerned with interesting projects connected with fuel metering equipment and hydraulic flying controls for aircraft.—Hobson Works, Fordhouses, Wolverhampton. [0420

THE Supermarine Works of Vickers-Armstrongs Ltd., invite applications for technical posts dealing with the development flight testing of fighter aircraft. Degree or equivalent qualification and some experience of similar or allied work essential. Write giving full particulars to: Personnel Department, Vickers-Armstrongs Ltd., Hursley Park, Nr. Winchester. [1940

PATENTS Department of the Bristol Aeroplane Co., Ltd., requires additional technical assistant experienced in the preparation and prosecution of patent applications; preferably passed intermediate examination of Institute of Chartered Patent Agents and between 25/35 years of age. Applications with full details to:—Chief Personnel Officer, Filton House, Bristol. [1946

HANDLEY PAGE (Reading), Ltd., The Aerodrome, Woodley, Reading, have vacancies in their design office for senior and intermediate draughtsmen and weightsmen. The work is on an interesting new project and there will be scope for rapid advancement to suitable applicants.—Please send full particulars of experience, etc., to the Personnel Officer. [0235

ARMSTRONG SIDDELEY MOTORS require a young engineer interested in the development of instrumentation for the flight testing of gas turbine aero engines. Some knowledge of electronics is desirable. Preferably applicants should possess a degree, though this is not essential.—Reply to Reference TGD2, Personnel Manager, Armstrong Siddeley Motors, Coventry. [1988

ELECTRONIC engineer for research laboratory. Senior position for engineer with experience of research and design of special circuits at medium to low frequencies. Knowledge of physics an advantage. Qualifications should include a good degree and preferably five years' experience in similar post. Interesting and rewarding work with excellent prospects for advancement. (Ref. 73).
SENIOR engineer for work in modern research laboratory on problems of high-speed switching, gas tube circuits and general pulse methods. Problems call for advanced techniques, good degree or equivalent in electronic engineering with not less than three years' experience required. (Ref. 74).
SENIOR servo-mechanism engineer for research work on complicated instrument type servo. Work involves analysis of present systems and design of new types. Experience of general electronics, gyro mechanisms and analogue computors an advantage. This post calls for a man with excellent qualifications and at least three years' experience on similar problems. (Ref. 75).
WRITE, in detail, quoting reference No. of position sought, to The Personnel Dept. (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [1923

PROJECT and design draughtsman, H.N.C. (aircraft wheels and brakes associated hydraulic systems). Must be able to work on own initiative through all stages of design and testing. Practical knowledge of machine shop work essential. Some knowledge of aircraft and hydraulics. Excellent conditions and prospects for advancement. Pension scheme.—Written application to Personnel Manager, The Goodyear Tyre and Rubber Co. (Gt. Britain), Ltd., Wallasey. [1996

SITUATIONS VACANT

MARSHALLS' FLYING SCHOOL, Ltd., Airport Works, Cambridge, require skilled woodworkers, preferably with aircraft experience. Hostel accommodation or subsistence allowance available.—Applications, with full details, to Employment Officer. [1997

DRAUGHTSMAN required for work on aircraft components. Experience in the aircraft industry desirable but not essential; good mechanical engineering draughtsman will be considered. Capable of working with the minimum of supervision. Write, giving particulars of age, experience and technical qualifications, to: King Aircraft Corporation, Fifth Street, Montrose Avenue, Hillington, Glasgow, S.W.2. [1933

SENIOR DRAUGHTSMEN

required for **AERO ENGINE INSTALLATION** work.

Some experience of airframe design is desirable. Good salaries and prospects for suitable applicants.
Superannuation scheme.
Arrangements made for interviews to take place locally and on Saturday mornings if necessary.
Please write in confidence, giving full details of experience, education and qualifications, to:

THE PERSONNEL OFFICER,
THE DE HAVILLAND ENGINE CO. LTD.
STAG LANE, EDGWARE
MIDDLESEX

GUIDED WEAPONS

SENIOR ELECTRO-MECHANICAL DESIGNER

is required for work connected with Guided Weapon development. Applicants should have suitable experience, with H.N.C. or higher qualifications, and be capable of controlling a design group.

Applications, with names of two referees, should be made to: Employment Manager, **Vickers-Armstrongs Limited, Weybridge Works, Weybridge, Surrey.**

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TO B.S. SPECIFICATION S.P.47

CROSS MFG. CO. (1938) LTD., COMBE DOWN, BATH

SITUATIONS VACANT

AIRFRAME stressmen are required for a design office in the south of England and salaries of £840 to £1,000 per annum are offered to applicants with six to 10 years' experience, and to those with three to five years' experience, £13 to £15 per week.—Please send particulars of experience, qualifications and age, stating whether married, to Box AC88922, Samson Clarks, 57-61 Mortimer Street, W.1. [0236

RADIO engineers required. Must be thoroughly experienced on airborne radio equipment including multi-channel V.H.F. of the latest type, American and English W/T, American radio compasses and all ancillary equipment. Experience on Dakota aircraft an advantage but not essential. N.J.C. rates of pay and terms of employment. Permanent positions.—Apply B.K.S. Engineering, Ltd., Southend Airport. [1973

ARMSTRONG SIDDELEY MOTORS require senior planning engineers for general machining work on gas turbine engines. Previous experience of gas turbines would be advantageous but not essential. Applicants with wide experience of general machining of other products would be considered.—Apply to Reference PE, Personnel Manager, Armstrong Siddeley Motors, Coventry. [1977

VACANCIES exist at Percival Aircraft, Ltd., for a number of senior stressmen on both military and civil aircraft and helicopter. Applicants must be capable of taking full responsibility for either a complete aircraft or a major component. Good salary with prospects to successful applicants and the positions carry monthly staff status.—Write, stating age, full details of experience, qualifications and previous appointments held, to the Personnel Manager, Percival Aircraft, Ltd., The Airport, Luton, Beds. [1900

SENIOR stressman for important and interesting work in the civil and military spheres of aeronautical engineering, embracing turbines for aircraft air conditiong, accessory installations, turboprops, small high-speed turbines and blowers. Applicants should be of degree standard with at least three years' experience in engine or allied fields. (Ref. 70).—Write in detail, quoting reference No. of position sought, to The Personnel Dept. (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [1922

TECHNICAL artists required for publications department. An interesting and varied work programme calls for ability to produce first-class perspectives in line and half-tone from blue-prints and personal investigation. Working conditions are excellent, the surroundings congenial and the positions permanent. Pension and assurance schemes exist and practical assistance with housing will be given.—Apply, stating age, experience, salary required, and quoting Ref. F/6, to the Personnel Officer, Saunders-Roe, Ltd., East Cowes, I.W. [1983

THE CIVIL SERVICE BOARD of the States of Jersey invites applications from qualified persons for appointment as air traffic control officer Grade III. Age at least 23 and under 35 on May 1st, 1954. Essential qualifications are alertness, good personality, physical fitness, tact and balanced judgment. Applicants must have a prescribed standard of educational attainments linked to the pre-1951 School Certificate with matriculation exemption standard, unless they joined the Armed Forces prior to 1946 and have aircrew experience in the Armed Forces or in civil aviation as pilot or navigator, or experience of duties directly concerned with the operation of air traffic control. A working knowledge of the French language will be an additional advantage. Air traffic control officers who are detailed for any course of instruction, the cost of which is borne by the States of Jersey, will be required to sign an agreement to remain in the employment of the States for at least five years.
SALARY ranges from £510 at age 23 to £670 at age 30 or over on entry, rising by annual increments to £875. Successful candidates will, subject to satisfactory service, be eligible for establishment in the Jersey Civil Service as vacancies occur.
APPLICATIONS should be sent to the Greffier of the States, States' Greffe, Jersey, giving date of birth, full details of experience and names and addresses of two referees, so as to arrive not later than May 21st, 1954. [1987

MINISTRY OF SUPPLY. Air traffic control officers. The Civil Service Commissioners invite applications for two pensionable Grade III posts—one at National Aeronautical Establishment, Bedford, the other at Radar Research Establishment, Defford, Worcs. Age at least 23 and under 35 on June 1st, 1954. Candidates must produce evidence of having reached a prescribed standard of educational attainments linked to the pre-1951 School Certificate with matriculation exemption standard, or hold an appropriate technical qualification. They must have had experience either as (a) aircrew in civil air transport, preferably as pilot or navigator, with considerable experience in the United Kingdom, or (b) pilot or navigator in the Armed Forces, preferably with considerable experience of air traffic control in the United Kingdom. Exceptionally, candidates without aircrew experience will be considered, provided they meet the educational requirements given above, and have had considerable practical experience either in civil aviation or in the Armed Forces of duties directly concerned with the operation of air traffic control. Additional assets will be a general knowledge of civil aviation legislation and practice, and of radio and radar aids to navigation, and a working knowledge of the French language. Starting salary according to age—£472 (at age 23) up to £728 (at 30 or over on entry). Maximum £964. Somewhat lower for women.—Further particulars and application form from Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 4323/54. Completed application forms to be returned by May 29, 1954. [1989

SITUATIONS VACANT

SAUNDERS-ROE, Ltd., have vacancies for senior and junior electrical engineers and draughtsmen in their aircraft design and research groups. Trained men with experience of testing and development of electrical equipment or with good D.O. experience are invited to apply. Preference will be given to men with qualifications up to A.M.I.E.E. standard. Pension and assurance schemes exist and practical assistance with housing will be given.—Apply, stating age, experience, salary required, and quoting Ref. P.5, to the Personnel Officer, Saunders-Roe, Ltd., East Cowes, I.W. [1984

SHORT BROTHERS and HARLAND LIMITED

LONDON DESIGN OFFICE

Applications are invited for the following positions which are pensionable and for which salaries paid will be commensurate with ability and experience

Applicants with aircraft experience preferred

SENIOR DESIGN AND DETAIL DRAUGHTSMEN

SENIOR STRESSMEN

WEIGHTS ENGINEERS

Apply stating age, experience and salary required to:—

The Manager
Short Brothers & Harland Ltd.
East India House
208A Regent Street,
London, W.1.

SITUATIONS VACANT

ARMSTRONG SIDDELEY MOTORS, Coventry, have vacancies for a number of designers and senior and junior draughtsmen. Although gas turbine experience is most advantageous it is not necessarily essential as training will be given in this specialized work to suitably qualified draughtsmen.—Apply, in detail, to Reference P.103, Personnel Manager, Armstrong Siddeley Motors, Coventry. [0200

SENIOR and Junior Stressmen vacancies for interesting programme of project and development work. Previous experience not essential for junior posts. H.N.C. minimum qualification. Salary in accordance with experience and qualifications. Limited housing accommodation available for selected applicants. Full particulars in writing to Personnel Manager, Flight Refuelling Ltd., Tarrant Rushton Airfield, nr. Blandford, Dorset. [1931

ARMSTRONG SIDDELEY MOTORS require 20 draughtsmen with Ordinary National Certificate or higher qualifications and sound engineering training for work in a rapidly expanding department in connection with rocket motors for aircraft propulsion. Applicants should preferably be between ages of 22 and 30. Permanent positions; staff pensions scheme available. —Apply to Reference D.1, Personnel Manager, Armstrong Siddeley Motors, Coventry. [1975

SENIOR scientific officers, scientific officers, patent examiner and patent officer classes. The Civil Service Commissioners invite applications for pensionable appointments. Applications may be accepted up to December 31st, 1954, but early application is advised as an earlier closing date may eventually be announced. Interview Boards will sit at frequent intervals. The scientific posts cover a wide range of scientific research and development in most of the major fields of fundamental and applied science. In biological subjects the number of vacancies is small: individual vacancies exist at present for candidates who have specialized in palaeobotany, foraminifera, malacology and lichenology. The patent posts are in the Patent Office (Board of Trade) and Ministry of Supply.

CANDIDATES must have obtained a university degree with first or second class honours in an appropriate scientific subject (including engineering) or in mathematics, or an equivalent qualification; or for scientific posts, possess high professional attainments. Candidates for senior scientific officer posts must in addition have had at least three years' post-graduate or other approved experience. Candidates for scientific officer and patent posts taking their degrees in 1954 may apply before the result of their degree examination is known.

AGE limits: Senior scientific officers, between 26 and 31, but specially suitable candidates under 26 may be admitted. For scientific officers and patent classes, between 21 and 28 during 1954 (up to 31 for permanent members of the experimental officer class). Salary (London) senior scientific officers: (men) £975 to £1,150; (women) £845 to £1,025. Scientific officers (men), £470 to £855; (women) £470 to £750. Patent examiner and patent officer classes (men), £440 to £760 (rates under review). Women's rates somewhat lower. Somewhat lower rates in the provinces.

FURTHER particulars from the Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.53/54 for senior scientific officers and S.52/54, S.128/54 for the other posts. [1981

BOOKS, ETC.

FOR sale, *Flight* bound volumes 1910-1912; details earliest planes. Offers.—Box 5033. [1971

SITUATIONS VACANT

THE BRISTOL AEROPLANE Co., Ltd., has vacancies in Bristol for senior technical illustrators. Applicants must be able to prepare fine line illustrations in black and white from workshop drawings and be able to prepare exploded and cut-away perspective engine views for technical publications. Salaries, pension scheme, working conditions and prospects of promotion on merit are excellent. Applications giving details of experience, age and qualifications should be addressed to:—The Personnel Manager, Engine Division, The Bristol Aeroplane Co., Ltd., Filton House, Bristol. [1947

FIXED AND ROTARY WING AIRCRAFT

We have immediate vacancies for:

AERODYNAMACISTS
Senior and Junior

TECHNICIANS
Senior and Junior
for structural analysis and aeroelastic work

Good working conditions
Superannuation

Salaries in accordance with experience

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Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1, by SUN PRINTERS LTD., London, and Watford Herts. *Flight* can be obtained abroad from the following: AUSTRALIA AND NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service, Ltd.; Gordon & Gotch, Ltd. SOUTH AFRICA: Central News Agency, Ltd.; Wm. Dawson & Sons (S.A.), Ltd. UNITED STATES: The International News Co. Entered as Second Class Matter at the New York, U.S.A., Post Office.

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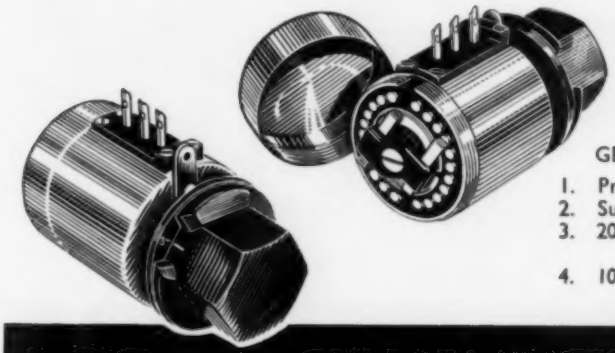

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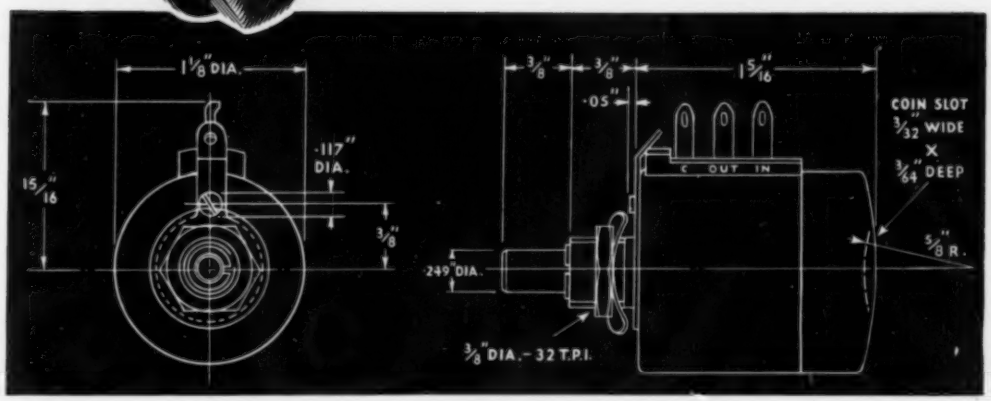

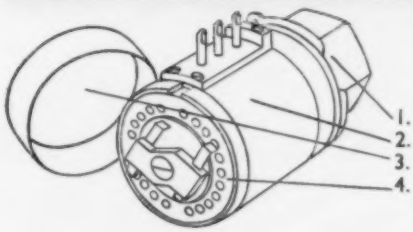

MECHANICAL CONSTRUCTION FEATURES

1. Entirely new and space-saving design Knob and Dial.
2. Contains Painton ¼-watt High Stability Carbon Resistors.
3. Removable cover for easy access to stud panel.
4. Beryllium-Copper Studs and Contact Arms.

PAINTON

Northampton England

ATTENUATORS AND FADERS • STUD SWITCHES • FIXED AND ADJUSTABLE WIREWOUND RESISTORS WIREWOUND POTENTIOMETERS • MIDGET R.F. CHOKES • HIGH STABILITY CARBON RESISTORS • TERMINALS PLUGS AND SOCKETS • KNOBS, DIALS AND POINTERS • TOGGLE SWITCHES • PUSH BUTTON SWITCHES

SYCAMORE

The Mark 4 Sycamore is a unique helicopter in that it has inbuilt provision for several operational roles: (1) A powered-winch is fitted for rescue work; (2) two stretcher patients can be accommodated within the cabin and tended in flight by a medical orderly; (3) with the stretchers folded and stowed in the 20 cu. ft. baggage compartment the cabin will seat five people; (4) a ventral sling permits the lifting of awkward loads over short distances; (5) spraying equipment can be fitted for crop treatment.

The "Bristol" Sycamore is powered by a 550 h.p. Alvis Leonides engine

THE Bristol AEROPLANE COMPANY LIMITED · ENGLAND

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